

NATIONAL GEOGRAPHIC

Angkor

WHY AN ANCIENT
CIVILIZATION COLLAPSED

**SPECIAL SUPPLEMENT:
THE KHMER EMPIRE**

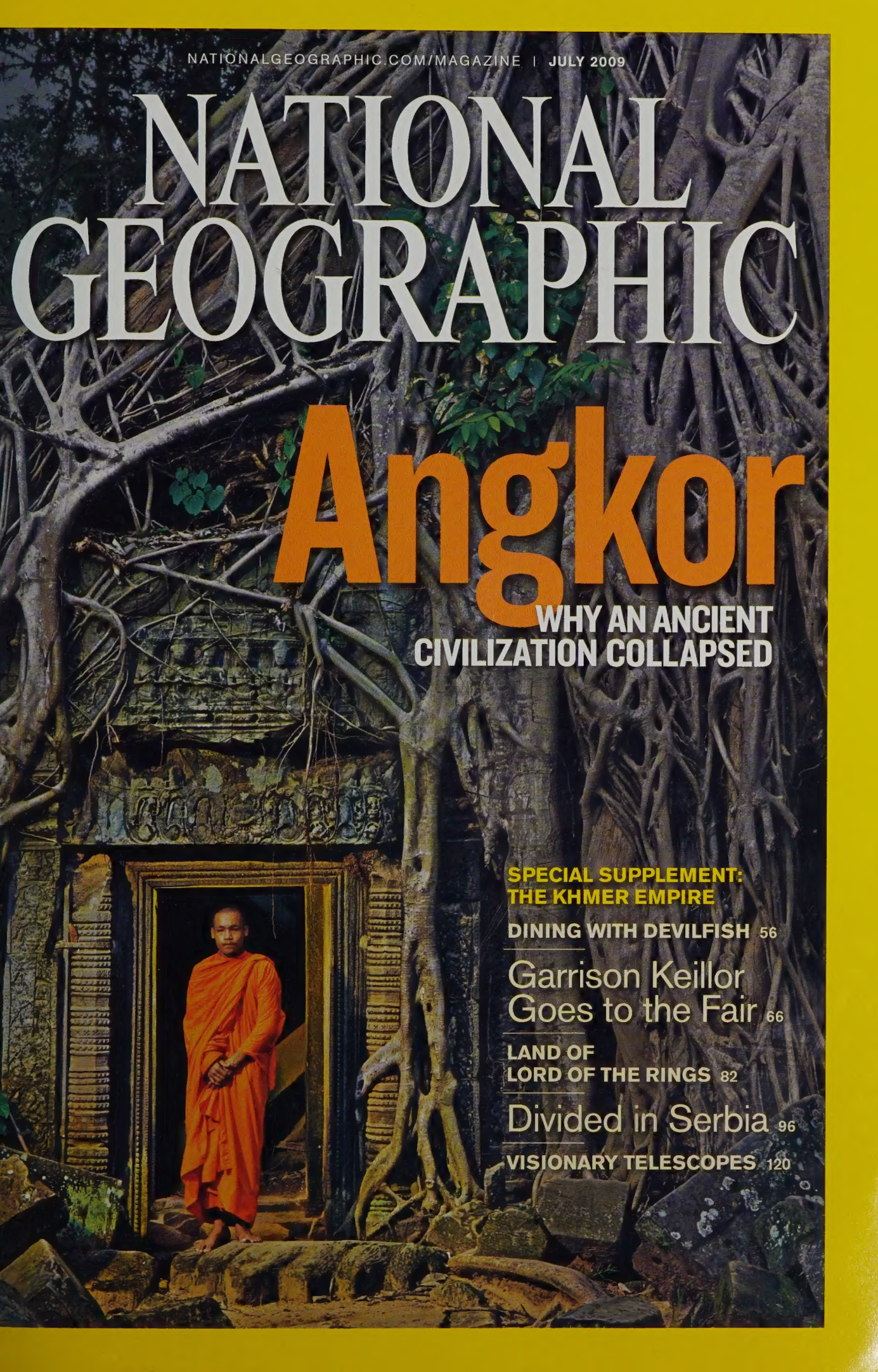
DINING WITH DEVILFISH 56

Garrison Keillor
Goes to the Fair 66

**LAND OF
LORD OF THE RINGS** 82

Divided in Serbia 96

VISIONARY TELESCOPES 120





THE LAWS OF GRAVITY DON'T APPLY TO EUPHORIA.

*My leash is broken. Nothing can keep me d
I can't find that kind of f
There's an e*



Page, Arizona *...ect for me,
... beaten path with everything
... makes this place and I a perfect fit
together. Nature can't be put on a leash, either.*

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NATIONAL GEOGRAPHIC

JULY 2009 • VOL. 216 • NO. 1

Answers From Angkor **26** The sacred city may have engineered its own downfall.
By Richard Stone Photographs by Robert Clark

Dining With Devilfish **56** Manta rays in the Maldives are frenzied feeders.
By Bruce Barcott Photographs by Thomas P. Peschak

Top Ten State Fair Joys **66** Be hypnotized! Gawk at cows! Indulge in fried Coca-Cola!
By Garrison Keillor Photographs by Joel Sartore

Land of *Lord of the Rings* **82** The fire and ice of a New Zealand park starred in the movie.
By Mel White Photographs by Stuart Franklin

Serbs Face the Future **96** They look at Kosovo with regret—and to Europe with hope.
By Chris Carroll Photographs by Christopher Anderson

Cosmic Vision **120** Giant telescopes take human eyes deep into space.
By Timothy Ferris Photographs by Joe McNally

Special Supplement: Angkor/Southeast Asia



These manta rays flip for food. Rolling like barrels, they suck up plankton in a fertile patch of a bay in the Maldives. Story on page 56.

THOMAS P. PESCHAK

NATIONAL GEOGRAPHIC

DEPARTMENTS

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CULTURE

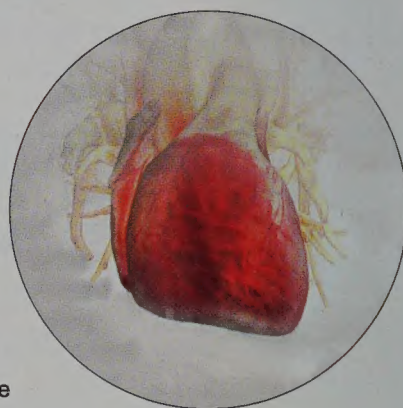
Spread of the Amish

Population is up. So is development in longtime heartlands. Colorado, here they come!

SCIENCE

Final Exam

What killed Herod? Columbus? Mozart? Modern-day doctors try to figure it out.



ENVIRONMENT

Friendlier Fire

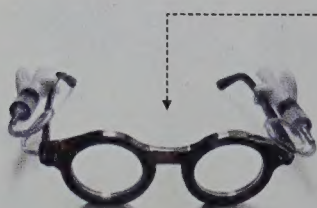
Fireworks can drop a toxic chemical into the water. Now there's an alternative.



TECHNOLOGY

The Eyes Have It

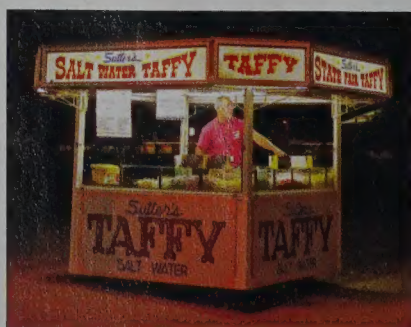
Self-correcting glasses bring sharper vision to the developing world.



Inside Geographic 140

Flashback

GeoPuzzle



JOEL SARTORE; REBECCA HALE, NG STAFF (GLASSES)

ngm.com

Send Us Your Corn Dogs

Actually, we don't want real ones. But we do want your photos of the greasy, battered treat and other state fair attractions for a special section of My Shot at ngm.com/statefair.

On the Cover

Forest roots at Ta Prohm temple are kept to evoke its pre-conservation look.

Photo by Robert Clark

BRIDGESTONE



the RAIN transforms

STREETS INTO SLIPPERY SLOPES,

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Thrill seekers take a whirl on a ride at the Texas state fair.

I got busted at the milk shake stand at my first state fair.

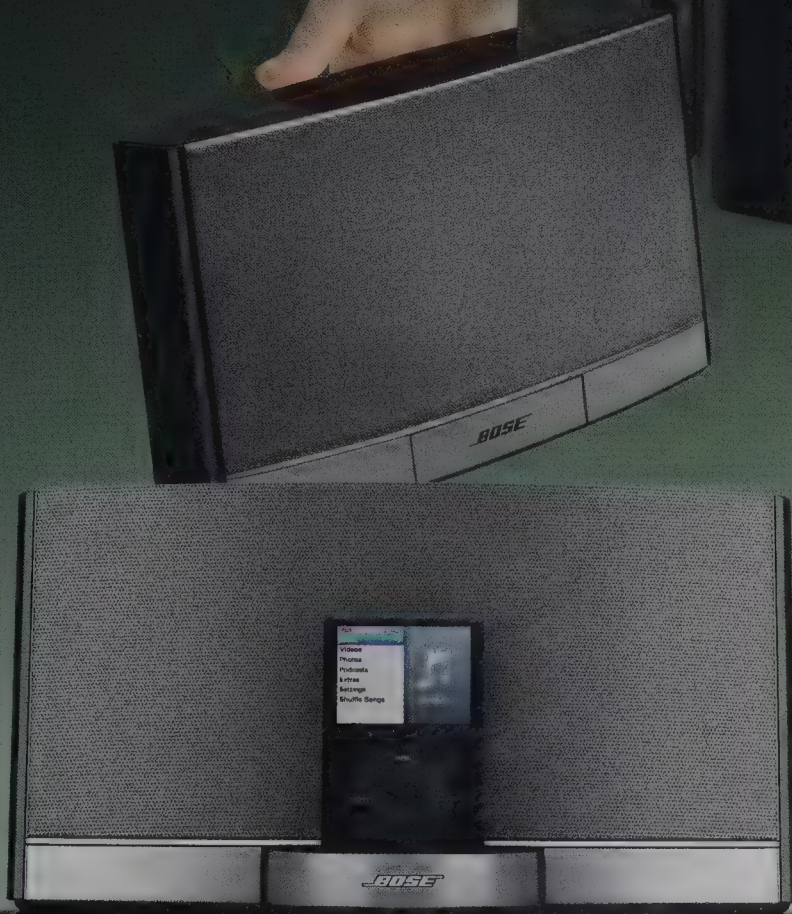
My father had dropped me off along with my prize hog at the Salem fairgrounds for the Oregon State Fair's livestock competition. He paid for a week's food and lodging in the 4-H dorm and went to visit his parents for the day. When he returned, we went to the Dairy Bar. It came time to pay for my milk shake. I was broke. My father asked what I'd done with all the money he gave me. I confessed I'd spent it all in two hours on the bumper cars.

Garrison Keillor would have understood. "The state fair," he writes in this month's feature, "is a ritual carnival marking the end of summer...and the start of school and higher algebra and the imposition of strict rules." Strict rules are for later. The state fair is about now—and the chance for a 12-year-old to cut loose before a new school year. With corn dog in hand (to eat food with two hands is one of the ten top joys of a state fair, Keillor observes), I was strolling down the boardwalk when the bumper cars called. I got behind the wheel. Time and quarters raced away.

Extreme centrifugal force is number two on Keillor's list of state fair joys. He mentions the double Ferris wheel and flume ride. Sissy stuff. I'll take the bumper cars every time.

A handwritten signature in black ink, which appears to read "Garrison Keillor".

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Hippopotamus (*Hippopotamus amphibius*)

Size: Body length, 300 - 540 cm (118.1 - 212.6 inches); shoulder height, 130 - 165 cm (51.2 - 65 inches); tail, approx. 56 cm (22 inches) **Weight:** 655 - 3,200 kg (1,444 - 7,055 lbs) **Habitat:** Found in most major rivers in sub-Saharan Africa; requires a permanent supply of water near large grazing areas **Surviving number:** Estimated at 125,000 - 148,000



Photographed by Beverly Joubert

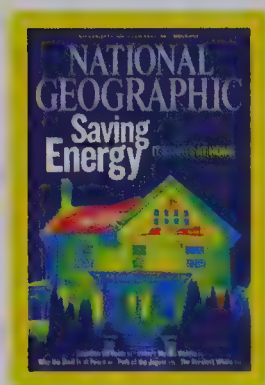
WILDLIFE AS CANON SEES IT

Fearsome, yes. But fragile, too. The hippopotamus is built like a tank, runs far faster than a man, and defends its territory with massive, razor-sharp tusks. Yet the enormous herbivore has a sensitive side; it spends all day in the water to prevent its thin skin from drying out, and secretes an oily reddish-pink substance to protect it from sunburn. It is also the linchpin in a finely balanced wetland ecosystem: if the hippopotamus and its fertilizing

dung are removed, local fish populations crash. Facing both habitat loss and poaching for meat and tusks, the hippopotamus is disappearing from its former range on a frighteningly large scale.

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March 2009

Scraping Bottom: The Canadian Oil Boom

I am a Canadian citizen and can assure you that not all Canadians favor the "development" of the oil sands. I believe that this is a shortsighted jump into disaster. I believe that the appropriate full environmental assessment has not been completed and that all the people affected have not been consulted and heard.

PETER MOGK
Milverton, Ontario

Oil sands mines are expensive, large-scale, long-life projects with a significant impact on the landscape before they are fully reclaimed. Industry has never argued this point. However, environmental impacts must be considered in context. Oil sands development creates hundreds of thousands of jobs and billions in investment and government revenues. The Canadian oil sands have a significant role to play in providing North America a means to reduce dependence on petroleum energy supply from less secure regions. The article provided no images of reclaimed sites, even though full reclamation is required by

law and the process is already well under way. Companies must submit detailed reclamation plans to government regulators prior to starting their projects and must pay a deposit into a government-administered fund over the project's life. To date, more than 25 square miles have been reclaimed.

DAVID COLLYER
President, Canadian Association
of Petroleum Producers
Calgary, Alberta

According to the government of Alberta, to date, 0.4 square miles of oil sands mining areas have been certified reclaimed. Another 25 square miles are now in the process of reclamation.

Some environmental groups have called for a halt to all oil sands mining. However, such a large reserve of hydrocarbons cannot be ignored and will certainly be developed. A regulated approach, with projects spaced at reasonable time intervals, would be wiser than the current policy. If parts of the deposit are not developed immediately, the reserve will only increase in value. A more measured approach will enable improved environmental procedures to catch up with production technology.

DOUG CRUICKSHANK
Calgary, Alberta

The greatest risk posed by Alberta's oil sands is the lobbying of politicians by oil sands companies to downgrade environmental standards and transfer responsibility for reclamation and waste to the taxpayers of Alberta.

TONY KAVANAGH
Calgary, Alberta

I worked in the oil sands and have done so for the past eight years. I do have concerns with the way the environment is raped and pillaged up here. I also have concerns as to how I will feed my family. The need for solid answers to these issues is of greater concern than the need to lash out at companies that feed the working half of Canada.

BILL RAHN
Armstrong, British Columbia

Saving Energy: It Starts at Home

Your article compared reducing personal CO₂ output with a new diet yet failed to mention that reducing meat in one's diet radically reduces CO₂ emissions. If you are serious about cutting down, simply start in your kitchen.

ROBERT JAMGOCHIAN
Mendocino, California

The idea that incremental energy savings by individuals could derail global warming is absurd. We need to solve the problem, not mitigate it. Make energy production CO₂ clean. No other action will suffice.

SETH SCOTT
Elmhurst, New York

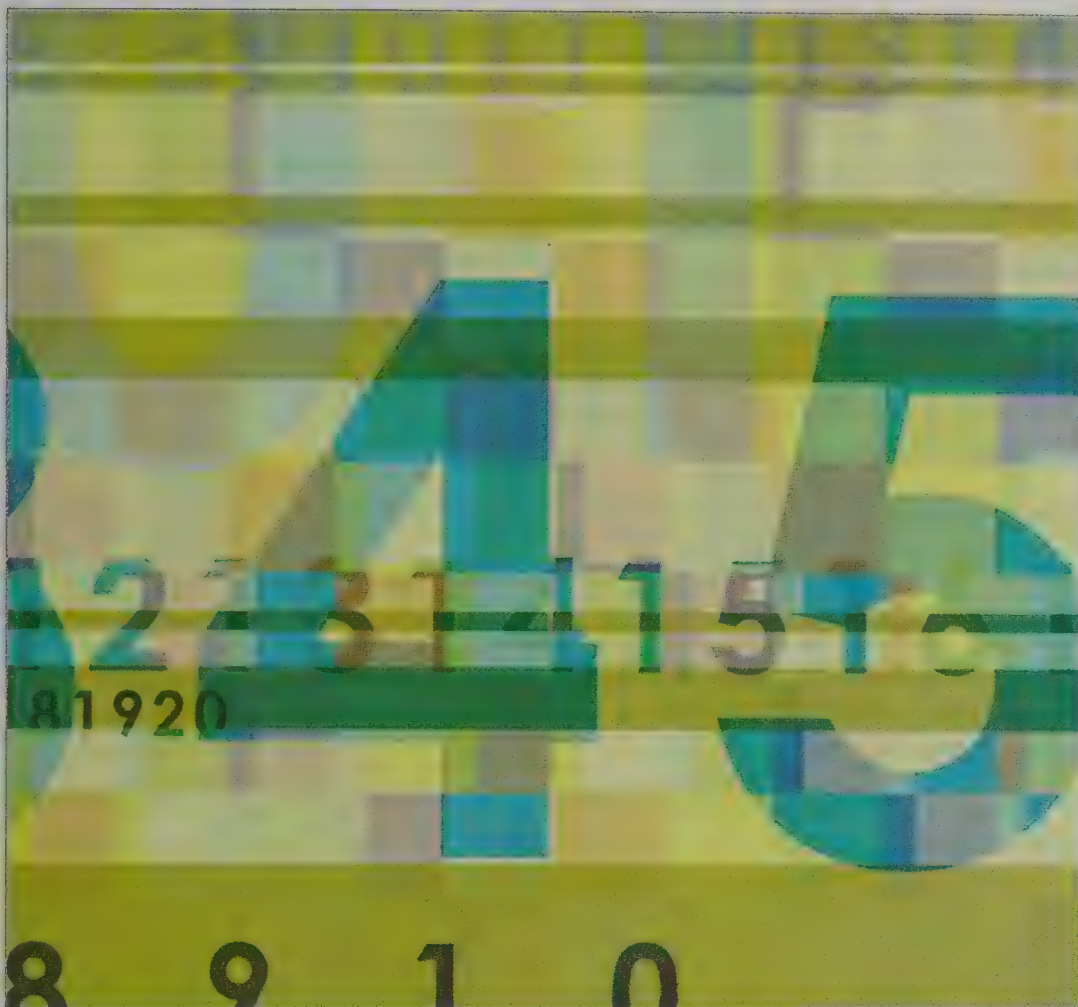
Corrections, Clarifications

March 2009: Saving Energy

Pages 80-81: The central chart incorrectly labeled emissions in metric tons of CO₂. It should have been labeled CO₂e, or carbon dioxide equivalent, which allows consistency in aggregation by expressing other gases in terms of the benchmark CO₂.

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EDITORS' CHOICE

Conor Dupre-Neary Kula, Hawaii

When an “extraordinary” moth alighted at Dupre-Neary’s living room window, the 27-year-old biological technician went outside for a better look. He got an even better picture: his dog, Jada, and the bug eyeing each other through the glass.

Susan Byrd Scottsdale, Arizona

Searching for “the essence of old China,” Byrd, 65, found two farmers admiring the centuries-old rice terraces that ridge the steep hills of Longsheng. Her shot was voted an *ngm.com* favorite.



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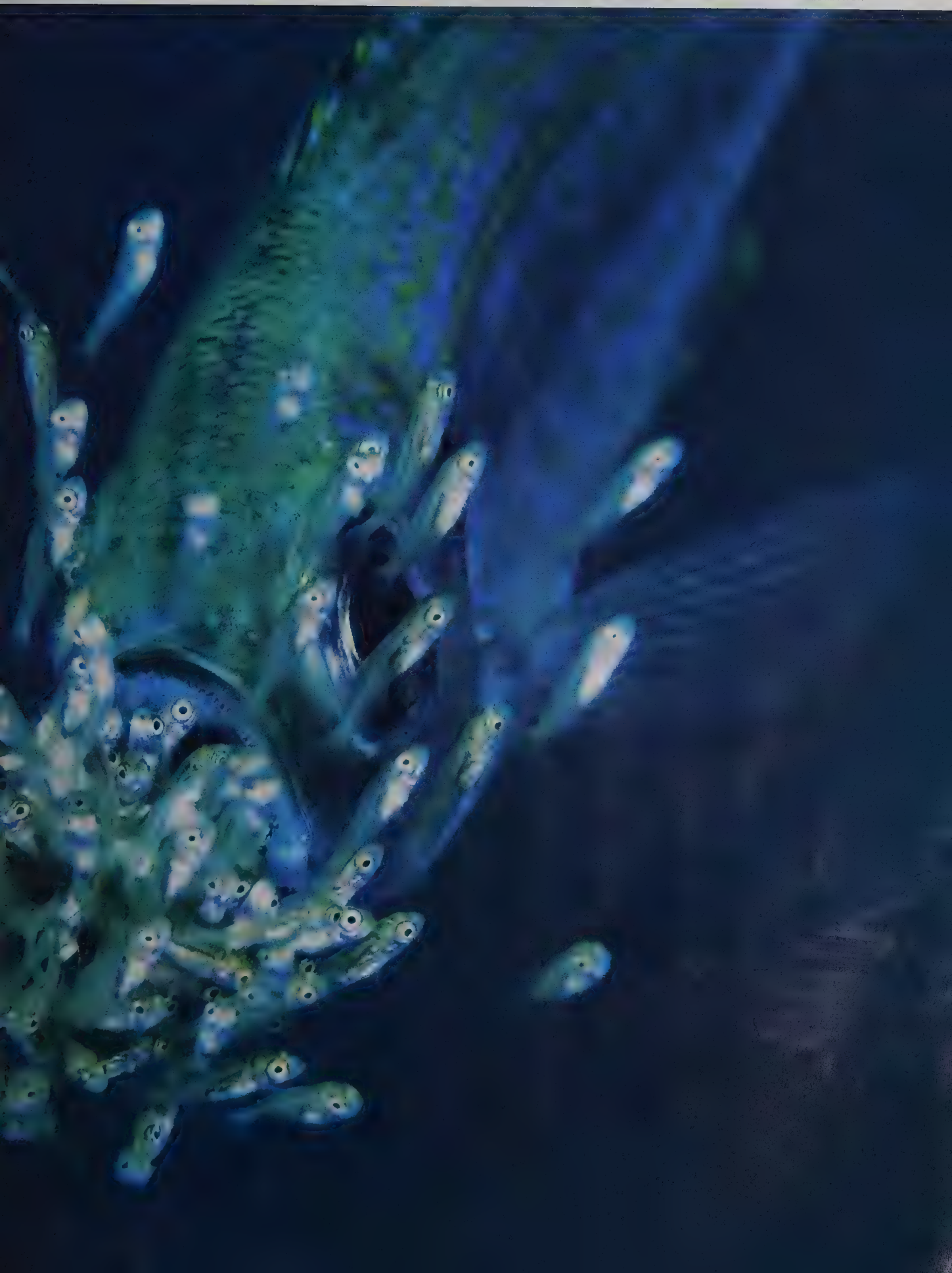
Tonga Plumes of ash, smoke, and steam billow thousands of feet into the air as an undersea volcano erupts on the uninhabited island of Hunga Ha'apai. The fallout, rock detritus known as scoria, has since enlarged the landmass.

PHOTO: DANA STEPHENSON, GETTY IMAGES



Tanzania After two weeks of in-mouth incubation, a school of perhaps 200 cichlid fry—each less than half an inch long—swim free of their mother, searching for a plankton meal in the cerulean waters of Lake Tanganyika.





India In Jammu, a flower of flame blooms from a man's kerosene-filled mouth. Devotees of Sikhism, the world's fifth largest organized religion, were marking the 342nd birthday of Guru Gobind Singh, a founder of the faith.



➤ Order prints of *National Geographic* photos online at **PrintsNGS.com**.

PHOTO: JAIPAL SINGH, EPA/CORBIS

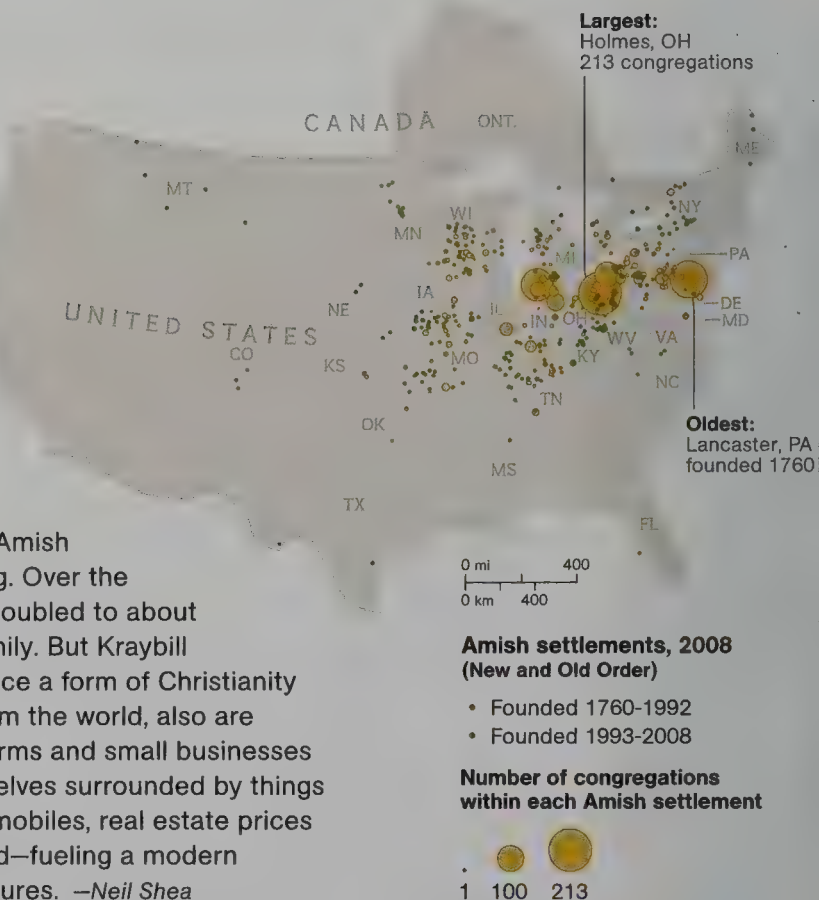


Spread of the Amish

If you live in Colorado, say, or Maine, maybe you've noticed a new kind of traffic: Amish horse buggies.

They're appearing in areas they've never been (or haven't been for a very long time), as Amish farming communities take root in states far beyond their traditional heartland of Pennsylvania, Indiana, and Ohio.

According to Donald Kraybill, a sociologist at Elizabethtown College, the Amish are moving partly because they're growing. Over the past 16 years, the population has nearly doubled to about 230,000, with roughly five children per family. But Kraybill explains that Amish adherents, who practice a form of Christianity emphasizing simplicity and separation from the world, also are feeling hemmed in. As towns near their farms and small businesses expand, Amish families have found themselves surrounded by things they've always tried to avoid—roads, automobiles, real estate prices that prohibit them from acquiring farmland—fueling a modern migration to greener, and more rural, pastures. —Neil Shea



Amish women walk a beach in Mississippi, one of several states in which new communities have arisen.

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in financial trouble cancelled a large order at the last minute so we grabbed all of them. He sold us an enormous cache of his roundest, whitest, most iridescent cultured 5 1/2-6mm pearls for only pennies on the dollar.

But let me get to the point: his loss is your gain. Many of you may be wondering about your next gift for someone special. In the past, Stauer has made gift giving easier with the absolute lowest prices on fine jewelry and luxury goods. This year, we've really come to the rescue.

For the next few days, I'm not offering this cultured pearl necklace at \$1,200. I'm not selling it for \$300. That's because I don't want to **SELL** you these pearls at all... I want to **GIVE** them to you. This cultured pearl necklace is yours **FREE**. You pay nothing except basic shipping and processing costs.

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Final Exam “Listen carefully to the patients, and they’ll tell you the diagnosis,” a medical maxim advises. But what if the patient’s been dead for a millennium?

The rule still applies, says Philip Mackowiak, chief of medicine at the Baltimore V.A. Medical Center. For the past 15 years Mackowiak has supervised the ultimate postmortem: a conference that challenges participants to deduce the cause of death for historical figures like Pericles, Columbus, and Mozart. Using evidence drawn from diaries, historical records, and contemporary accounts, presenters perform theoretical autopsies, which help them refine their ability to diagnose living patients.

Social history is important to consider. Beethoven, for instance, never married. His writings mention prostitutes, and that supports a disputed diagnosis of syphilis, which could have caused his deafness and claimed his life.

The cold cases in the extreme also humanize the celebrity corpses—sometimes more than we’d like. Says Faith Fitzgerald, an internist who dissected Mozart’s medical history: “We are disquieted when extraordinary people die from ordinary things.” —Cathy Newman

ABSTRACT AUTOPSIES

Here are five notable figures and the diseases that may have done them in.

COLUMBUS

1451-1506

Reactive arthritis, following a bacterial infection caught from parrots aboard his ship, might have been fatal to the New World explorer.

HEROD

73-4 B.C.

The king of Judaea seems to have suffered from hardening of the arteries and may have died of heart failure.

MOZART

1756-91

The composer was likely afflicted by a streptococcal infection, which might have led to a fatal heart disease or kidney disorder.

ALEXANDER

356-323 B.C.

Progressive weakness and severe abdominal pain point to typhoid fever as the cause of the Macedonian king’s demise.

PERICLES

495-429 B.C.

References to a blistering rash and accounts of the Plague of Athens make smallpox the Greek statesman’s likely cause of death.

See The Bigger Picture

Biodiversity Photo Contest



Renowned National Geographic photographer Joel Sartore brings us face-to-face with biodiversity loss. His photographs of endangered species often give the world a final glimpse of vanishing life.

A world of amazing connections "Biodiversity is beautiful. The spectacular variety of life on Earth keeps our planet healthy and balanced. When I travel the world as a photographer, I see that the intricate connections between all species—from the smallest insects to the largest trees—are fragile and threatened. When we lose species we lose connections and that can trigger chain reactions reaching all the way to you and me. In parts of the world, bees have vanished, so people now have to hand-pollinate fruits and vegetables with feathers. When snake species are lost, mouse populations skyrocket, invading our crops. As chameleons, other reptiles, and amphibians vanish, massive numbers of insects will remain uneaten, many of which carry disease to humans. Trees and other plants that are so invaluable in providing medicines and cleaning our soil, water, and air are disappearing faster than ever before.

The one thing we can't lose is hope. We still have time to turn things around. Our children will inherit a world rich—or poor—in biodiversity based on how much we preserve and protect today. My photos are my way of asking us all to stop, look, and care."



Get your children to stop and look and enter the See The Bigger Picture Photo Contest.

Submit photos, learn more about biodiversity, and see full contest rules at www.seethebiggerpicture.org

Airbus sees the bigger picture, and works to minimize environmental impact by reducing greenhouse gas emissions, lowering fuel consumption, and creating quieter, more efficient aircraft. Airbus created the first aircraft recycling program of its kind in the world, and earned the ISO 14001 Environmental Certification. Together, Airbus and National Geographic support the UN-backed project, *The Green Wave*, in the world's most far-reaching biodiversity program to children, youth, and families.

 **THE GREEN WAVE**
ONE SCHOOL, ONE TREE, ONE GIFT TO NATURE.  



AIRBUS



New high-nitrate fireworks don't add much smoke to an indoor space.

Friendlier Fire

The EPA is worried about fireworks. It's not so much the noise and smoke—it's the toxic chemical that provides the oxygen needed to burn the fuel.

The culprit is perchlorate, and the fear is it could seep into drinking water. Early research suggests it might hinder the thyroid's production of growth hormones, notably in children and pregnant women. "It deserves more study," says EPA spokesman Rick Wilkin.

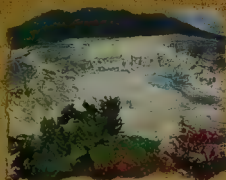
After a fireworks blast, bits of perchlorate can land in nearby water. Poor cleanup of duds adds to contamination. And perchlorate lingers. In a study of an Oklahoma lake from 2004 to 2006, levels spiked following a fireworks show and took 20 to 80 days to stabilize. Why the range? The warmer the water, the faster the perchlorate dissipated.

Chemists Darren Naud and Mike Hiskey have devised a solution. Most of the fireworks made by their New Mexico company use cleaner burning, nitrate-based oxidants instead of perchlorate. This low-smoke variety is ideal for indoor shows like Cirque du Soleil, but outdoor venues opt for Chinese imports, which are far cheaper. Without laws regulating perchlorate, event planners aren't likely to spend more bucks for their bang. —Catherine L. Barker



*No camera will store
as much as your heart.*

Tortuguero National Park



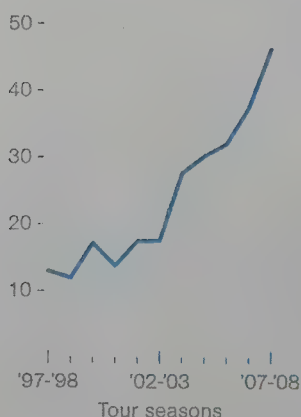
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Tourist Sean Farrell dives into 30°F Antarctic waters without a wet suit before swimming—quickly—back to the boat.

SOUTHERN EXPOSURE

Number of tourists visiting Antarctica, in thousands



Ice Overflow When Los Angeles attorney Sean Farrell plunged into the numbing ocean off the Antarctic Peninsula in 2007 (above), the view was just what he had hoped: a vast white wilderness. But every few days Farrell, who was on a chartered yacht, spied tourist boats in the distance. A spike in visitors to Antarctica—up 250 percent during the past decade to 46,000—has Farrell wondering if the great white continent wouldn't be better off if he'd stayed home. "Everybody wants to see natural beauty," he says. "But even the most conscientious traveler will have an impact."

So far the tourist industry has policed itself. Guidelines forbid ships with more than 500 passengers from landing on the continent, and groups of more than a hundred from going ashore. But the more ships, the greater the risk to the environment. When the aging vessel *Explorer* sank in 2007, it created a mile-long oil slick. Newcomers to the route present problems as well. The latest cruise ships, some carrying more than a thousand tourists, aren't strengthened to withstand possible collisions with sea ice.

Environmentalists are calling for laws to curb tourism growth. Through 2010, economic forces may be enough. Visitor numbers will likely flatten as spending slows. —Karen E. Lange



You'll never forget that day.

PLAVIX can help keep you from going through it again.



PLAVIX can help save lives for those who've had a heart attack caused by a completely blocked artery.



Clots that block off arteries are the main cause of heart attack. And now that you've had a heart attack you are at a greater risk of having another that can be fatal. That's why your doctor may put you on PLAVIX, along with your

other heart medicines. Taking PLAVIX with your other heart medicines goes beyond what other heart medicines alone can do to keep blood platelets from sticking together and forming dangerous clots.



IMPORTANT SAFETY INFORMATION: If you have a stomach ulcer or other condition that causes bleeding, you should not use PLAVIX. When taking PLAVIX alone or with some other medicines including aspirin, the risk of bleeding may increase so tell your doctor before planning surgery. And, always talk to your doctor before taking aspirin or other medicines with PLAVIX, especially if you've had a stroke. If you develop fever, unexplained weakness or confusion, tell your doctor promptly as these may be signs of a rare but potentially life-threatening condition called TTP, which has been reported rarely, sometimes in less than 2 weeks after starting therapy. Other rare but serious side effects may occur.

Ask your doctor how PLAVIX can help increase your protection against future heart attack, stroke, and even death.

To learn more about heart attacks and PLAVIX, visit www.plavix.com or call 1-800-230-9202.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

See important product information on the following page.

If you need help paying for prescription medicines, you may be eligible for assistance. Call 1-888-4PPA-NOW (1-888-477-2669), or go to www.pparx.org



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(clopidogrel bisulfate) 75mg tablets

Protection that helps save lives.

WHO IS PLAVIX FOR?

PLAVIX is a prescription-only medicine that helps keep blood platelets from sticking together and forming clots.

PLAVIX is for patients who have:

- had a recent heart attack.
- had a recent stroke.
- poor circulation in their legs (Peripheral Artery Disease).

PLAVIX in combination with aspirin is for patients hospitalized with:

- heart-related chest pain (unstable angina).
- heart attack.

Doctors may refer to these conditions as ACS (Acute Coronary Syndrome).

Clots can become dangerous when they form inside your arteries. These clots form when blood platelets stick together, forming a blockage within your arteries, restricting blood flow to your heart or brain, causing a heart attack or stroke.

WHO SHOULD NOT TAKE PLAVIX?

You should NOT take PLAVIX if you:

- are allergic to clopidogrel (the active ingredient in PLAVIX).
- have a stomach ulcer
- have another condition that causes bleeding.
- are pregnant or may become pregnant.
- are breast feeding.

WHAT SHOULD I TELL MY DOCTOR BEFORE TAKING PLAVIX?

Before taking PLAVIX, tell your doctor if you're pregnant or are breast feeding or have any of the following:

- gastrointestinal ulcer
- stomach ulcer(s)
- liver problems
- kidney problems
- a history of bleeding conditions

WHAT IMPORTANT INFORMATION SHOULD I KNOW ABOUT PLAVIX?

TTP: A very serious blood condition called TTP (Thrombotic Thrombocytopenic Purpura) has been rarely reported in people taking PLAVIX. TTP is a potentially life-threatening condition that involves low blood platelet and red blood cell levels, and requires urgent referral to a specialist for prompt treatment once a diagnosis is suspected. Warning signs of TTP may include fever, unexplained confusion or weakness (due to a low blood count, what doctors call anemia). To make an accurate diagnosis, your doctor will need to order blood tests. TTP has been reported rarely, sometimes in less than 2 weeks after starting therapy.

Gastrointestinal Bleeding: There is a potential risk of gastrointestinal (stomach and intestine) bleeding when taking PLAVIX. PLAVIX should be used with caution in patients who have lesions that may bleed (such as ulcers), along with patients who take drugs that cause such lesions.

Bleeding: You may bleed more easily and it may take you longer than usual to stop bleeding when you take PLAVIX alone or in combination with aspirin. Report any unusual bleeding to your doctor.

Geriatrics: When taking aspirin with PLAVIX the risk of serious bleeding increases with age in patients 65 and over.

Stroke Patients: If you have had a recent TIA (also known as a mini-stroke) or stroke taking aspirin with PLAVIX has not been shown to be more effective than taking PLAVIX alone, but taking aspirin with PLAVIX has been shown to increase the risk of bleeding compared to taking PLAVIX alone.

Surgery: Inform doctors and dentists well in advance of any surgery that you are taking PLAVIX so they can help you decide whether or not to discontinue your PLAVIX treatment prior to surgery.

WHAT SHOULD I KNOW ABOUT TAKING OTHER MEDICINES WITH PLAVIX?

You should only take aspirin with PLAVIX when directed to do so by your doctor. Certain other medicines should not be taken with PLAVIX. Be sure to tell your doctor about all of your current medications, especially if you are taking the following:

- aspirin
- nonsteroidal anti-inflammatory drugs (NSAIDs)
- warfarin
- heparin

Be sure to tell your doctor if you are taking PLAVIX before starting any new medication.

WHAT ARE THE COMMON SIDE EFFECTS OF PLAVIX?

The most common side effects of PLAVIX include gastrointestinal events (bleeding, abdominal pain, indigestion, diarrhea, and nausea) and rash. This is not a complete list of side effects associated with PLAVIX. Ask your doctor or pharmacist for a complete list.

HOW SHOULD I TAKE PLAVIX?

Only take PLAVIX exactly as prescribed by your doctor. Do not change your dose or stop taking PLAVIX without talking to your doctor first.

PLAVIX should be taken around the same time every day, and it can be taken with or without food. If you miss a day, do not double up on your medication. Just continue your usual dose. If you have any questions about taking your medications, please consult your doctor.

OVERDOSAGE

As with any prescription medicine, it is possible to overdose on PLAVIX. If you think you may have overdosed, immediately call your doctor or Poison Control Center, or go to the nearest emergency room.

FOR MORE INFORMATION

For more information on PLAVIX, call 1-800-633-1610 or visit www.PLAVIX.com. Neither of these resources, nor the information contained here, can take the place of talking to your doctor. Only your doctor knows the specifics of your condition and how PLAVIX fits into your overall therapy. It is therefore important to maintain an ongoing dialogue with your doctor concerning your condition and your treatment.

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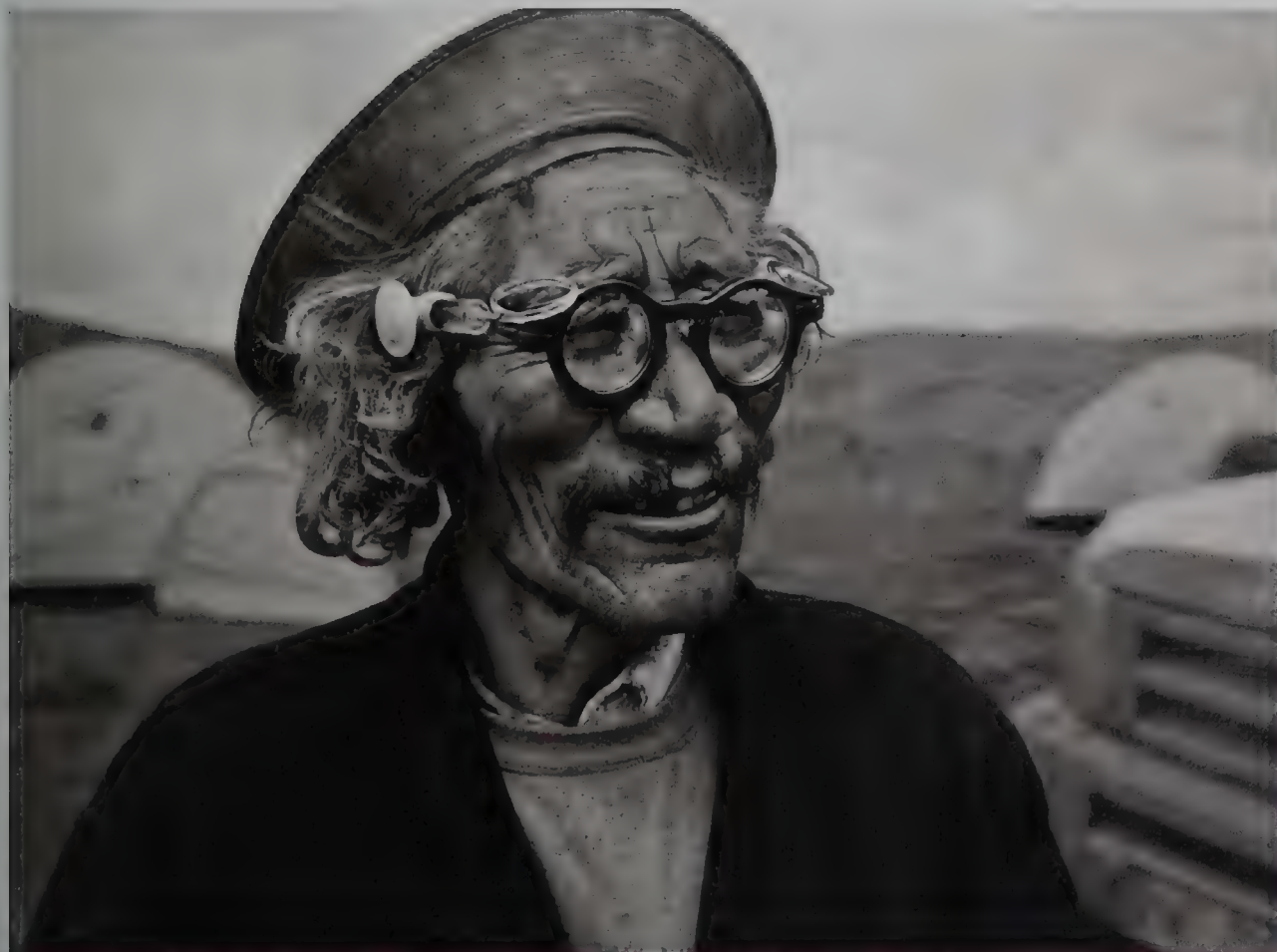
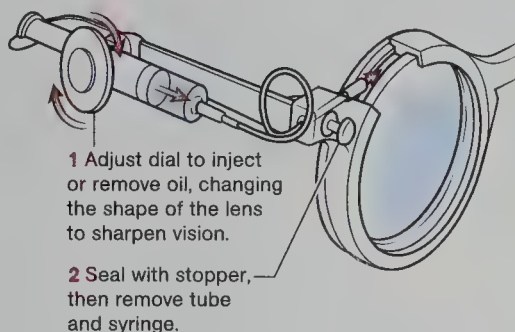
The Eyes Have It More than a billion people in the developing world need glasses. But opticians aren't exactly on every block in sub-Saharan Africa. In some places the ratio is one to one million residents. Pondering this problem, Oxford University physics professor Joshua Silver came up with a brilliantly simple solution: a pair of eyeglasses, currently costing about \$19, that the wearer can adjust. Silicone oil is injected into a gap between two sheets of plastic until the lens provides sharp vision (right). The inventor's field research shows the correction can be better than that of prefab glasses sold at a store.

As director of the new nonprofit Centre for Vision in the Developing World, Silver envisions a billion pairs on needy eyes by 2020. So far, 30,000 pairs are in use in Africa and eastern Europe, two-thirds distributed through U.S. military aid programs.

The glasses look a bit geeky, but there are few complaints. Silver recalls the first recipient, in Ghana in 1996: a tailor in his 30s whose faltering close vision made it nearly impossible to thread a needle. The tailor adjusted the glasses, threaded the needle on his machine, and began sewing rapidly. "I will not forget that moment," says Silver, "until I entirely lose my memory." —Marc Silver

CORRECT YOURSELF

Adaptive eyeglasses can be adjusted for close or distance vision.



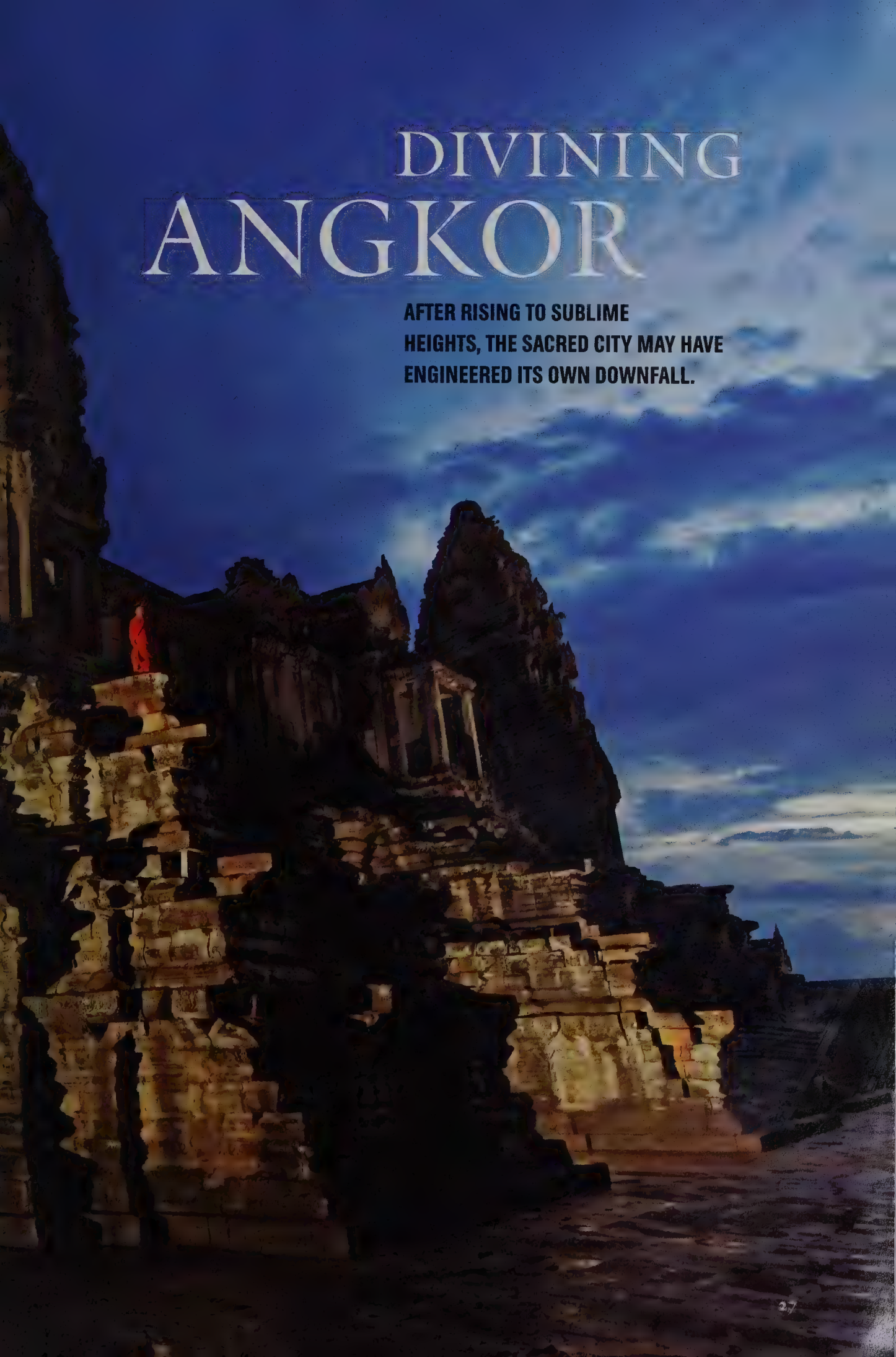
This man in a remote Tibetan village received his adaptive glasses in 2005.



Icon of Khmer civilization, Angkor Wat in Cambodia endures as a revered religious shrine.

DIVINING ANGKOR

**AFTER RISING TO SUBLIME
HEIGHTS, THE SACRED CITY MAY HAVE
ENGINEERED ITS OWN DOWNFALL.**



A large, dark, out-of-focus silhouette of a young boy is in the foreground, swimming in a body of water. The background shows a calm body of water reflecting the sky and distant trees and structures under a cloudy sky.

For local boys the moat at Angkor Wat is a swimming hole. In the 12th century it symbolized the oceans encircling the home of the gods. It also had a practical use: storing water for the city's large population.

FRITZ HOFFMANN





Once viewed solely as a sacred site with a temple in its middle, the five-mile-long West Baray is also understood as a hub of a vast water-management system, crucial to Angkor's wealth and power.



BY RICHARD STONE

PHOTOGRAPHS BY ROBERT CLARK

From the air, the centuries-old temple appears and vanishes like a hallucination. At first it is no more than an umber smudge in the forest canopy of northern Cambodia. Beneath us sprawls the lost city of Angkor, now in ruins and populated mostly by peasant rice farmers. Clusters of Khmer homes, perched on spindly stilts to cope with flooding during the summer monsoon,

dot the landscape from the Tonle Sap, the “great lake” of Southeast Asia, some 20 miles to the south, to the Kulen Hills, a ridge jutting from the floodplain a roughly equal distance to the north. Then, as Donald Cooney guides the ultralight plane over the treetops, the magnificent temple comes into view.

Restored in the 1940s, the 12th-century Banteay Samre, devoted to the Hindu god Vishnu, recalls the medieval Khmer Empire at its height. The temple is cloistered inside two sets of concentric square walls. These may once have been surrounded by a moat symbolizing the oceans encircling Mount Meru, mythical home of Hindu gods. Banteay Samre is just one of more than a thousand shrines the Khmer erected in the city of Angkor during a building spree whose scale and ambition rivals the pyramids of Egypt. After we pass, I crane my neck for a last look. The temple has disappeared into the forest.

Angkor is the scene of one of the greatest vanishing acts of all time. The Khmer kingdom lasted from the ninth to the 15th centuries, and at its height dominated a wide swath of Southeast Asia, from Myanmar (Burma) in the west to Vietnam in the east. As many as 750,000 people lived in Angkor, its capital, which sprawled across an area the size of New York City's five boroughs, making it the most extensive urban complex of the preindustrial world. By the late 16th century, when Portuguese missionaries came upon the lotus-shaped towers of Angkor Wat—the most elaborate of the city's temples and the world's largest religious monument—the once resplendent

capital of the empire was in its death throes.

Scholars have come up with a long list of suspected causes, including rapacious invaders, a religious change of heart, and a shift to maritime trade that condemned an inland city. It's mostly guesswork: Roughly 1,300 inscriptions survive on temple doorjambs and freestanding stelae, but the people of Angkor left not a single word explaining their kingdom's collapse.

Recent excavations, not of the temples but of the infrastructure that made the vast city possible, are converging on a new answer. Angkor, it appears, was doomed by the very ingenuity that transformed a collection of minor fiefdoms into an empire. The civilization learned how to tame Southeast Asia's seasonal deluges, then faded as its control of water, the most vital of resources, slipped away.

AN INTRIGUING FIRSTHAND ACCOUNT brings the city to life at its zenith. Zhou Daguan, a Chinese diplomat, spent nearly a year in the capital at the end of the 13th century. He lived modestly as a guest of a middle-class family who ate rice using coconut-husk spoons and drank wine made from honey, leaves, or rice. He described a gruesome practice, abandoned not long before his visit, that involved collecting human gall from living donors as a tonic for courage. Religious festivals featured fireworks and boar fighting. The greatest spectacles occurred when the king ventured out among his subjects. Royal processions included elephants and horses decorated with gold, and hundreds of palace women bedecked in flowers.



Lotus flowers and Hindu deities carved in stone mark the holy site of Kbal Spean in the Kulen Hills, the source of two rivers that nourish the Angkor floodplain.

Angkor's daily rhythms also come to life in sculptures that have survived centuries of decay and, more recently, war. Bas-reliefs on temple facades depict everyday scenes—two men hunched over a board game, for instance, and a woman giving birth under a shaded pavilion—and pay homage to the spiritual world inhabited by creatures such as *apsaras*, alluring celestial dancers who served as messengers between humans and the gods.

The bas-reliefs also reveal trouble in paradise. Interspersed with visions of earthly harmony and sublime enlightenment are scenes of war. In one bas-relief, spear-bearing warriors from the neighboring kingdom of Champa are packed stem to stern in a boat crossing the Tonle Sap. The scene is immortalized in stone, of course, because the Khmer were successful in battle.

Although Angkor won that clash, the city was riven by rivalry, which heightened its vulnerability to attacks from Champa to the east and the formidable kingdom of Ayutthaya to

the west. Khmer kings had several wives, which blurred the line of succession and resulted in constant intrigue as princes vied for power. "For centuries, it was like the Wars of the Roses. The Khmer state was often unstable," says Roland Fletcher, an archaeologist at the University of Sydney and co-director of a research effort called the Greater Angkor Project.

Some scholars believe that Angkor died the way it lived: by the sword. The annals of Ayutthaya state that warriors from that kingdom "took" Angkor in 1431. No doubt the prosperous Khmer city would have been a rich prize: Inscriptions boast that its temple towers were clad in gold, as Zhou's breathless account confirms. To reconcile tales of Angkor's wealth with

ROYAL PROCESSIONS INCLUDED ELEPHANTS AND HORSES DECORATED WITH GOLD, AND HUNDREDS OF PALACE WOMEN BEDECKED IN FLOWERS.

the dilapidated ruins encountered by Western travelers, French historians a century ago concluded from the tantalizing allusion that Ayutthaya sacked Angkor.

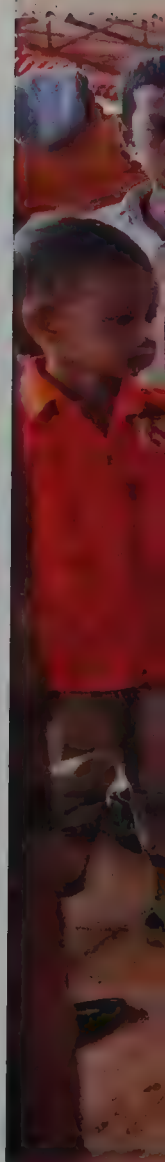
Fletcher, who says his obsession is to “figure out what makes settlements grow and die,” is dubious. Some early scholars, he says, viewed Angkor through the lens of the sieges and conquests of European history. “The ruler of Ayutthaya, indeed, says he took Angkor, and he may have taken some formal regalia back to Ayutthaya with him,” says Fletcher. But after Angkor was captured, Ayutthaya’s ruler installed his son on the throne. “He’s not likely to have smashed the place up before giving it to his son.”

Court intrigue may not have perturbed most of Angkor’s subjects, but religion was central to daily life. Angkor was what anthropologists call a regal-ritual city. Its kings claimed to be the world emperors of Hindu lore and erected temples to themselves. But as Theravada Buddhism gradually eclipsed Hinduism in the 13th and 14th centuries, its tenet of social equality may have threatened Angkor’s elite. “It was very subversive, just like Christianity was subversive to the Roman Empire,” says Fletcher. “It would have been exceedingly difficult to stop.”

Such a religious shift would have eroded royal authority. The regal-ritual city operated on a moneyless economy, relying on tribute and taxation. The kingdom’s de facto currency was rice, staple of the conscripted laborers who built the temples and the cast of thousands who ran them. An inscription at one complex, Ta Prohm, notes that 12,640 people serviced that temple alone. The inscription also records that more than 66,000 farmers produced nearly 3,000 tons of rice a year to feed this multitude of priests, dancers, and temple workers. Add just three large temples to the equation—Preah Khan and the larger complexes of Angkor Wat and the Bayon—and the calculated farm labor required swells to 300,000. That’s nearly half of the estimated population of Greater Angkor. A new, egalitarian religion such as Theravada Buddhism might have led to rebellion.

Or maybe the royal court simply turned its

Resembling the apsaras, the beautiful dancers who appear on many of Angkor’s temple walls, 17-year-old Sonsa Ry bends to tradition and washes her husband’s feet at their wedding in the village of Thnal Toteung.



back on Angkor. Successive rulers had a habit of erecting new temple complexes and letting older ones decay, and that penchant for starting anew might have doomed the city when sea trade began to flourish between Southeast Asia and China. Maybe it was simple economic opportunism that, by the 16th century, had caused the Khmer center of power to shift to a location closer to the Mekong River, near Cambodia’s present-day capital, Phnom Penh, affording it easier access to the South China Sea.

Economic and religious turmoil may have hastened Angkor’s downfall, but its rulers were blindsided by another foe. Angkor became a medieval powerhouse thanks to a sophisticated system of canals and reservoirs that enabled the city to hoard scarce water in dry months and



disperse excess water during the rainy season. Forces beyond Angkor's control threw this exquisitely tuned machine into disarray.

ONE OF ANGKOR'S HOLIEST SITES is high in the Kulen Hills at the headwaters of two rivers, the Puok and the Siem Reap. Under the shade of gnarled strangler fig trees, submerged in the clear water of a lazy creek, are row after row of circular bumps, each about six inches wide, carved into the dark sandstone riverbed. These are worn lingams, cylindrical stone sculptures representing the essence of the Hindu god Shiva. The lingams lead like a road to another sculpture in the riverbed: a thick-walled square, a yard wide, with a narrow inlet. It's a yoni, a symbol of the Hindu source of life.

Angkor's high priests came here to thank the gods for providing the lifeblood of the kingdom. A short walk upstream is a natural bridge of sandstone that lends this holy site its name, Kbal Spean—Khmer for "bridgehead." Water rushes through a cleft, splashing an adjoining rock face where Vishnu, legs crossed, meditates atop an angry ocean; sprouting from his navel is a lotus-flower-bearing Brahma. Here in the Kulen Hills the ancient gods enjoy perpetual libations from flowing water.

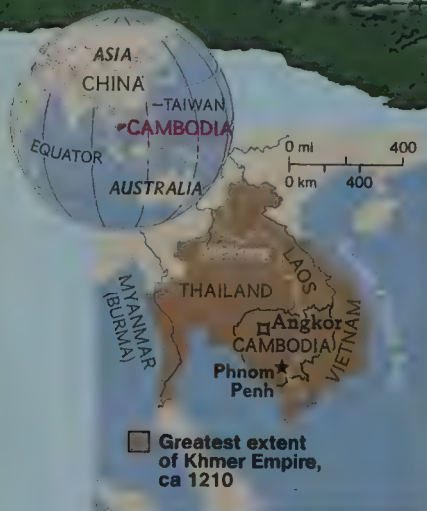
By harnessing the monsoon tide that gushed from the Kulen Hills, *(Continued on page 48)*

Beijing-based writer Richard Stone is Asia editor for Science magazine. Robert Clark has photographed more than a dozen cover stories for the Geographic.

IMPERIAL ANGKOR

ITS VAST WATER SYSTEM WAS A MARVEL OF ENGINEERING—AND A CAUTIONARY TALE OF TECHNOLOGICAL OVERREACH.

At its height in the 13th century (depicted in this reconstruction), the capital of the Khmer Empire was the most extensive urban complex in the world. Using imaging radar and other tools, researchers have learned that Greater Angkor covered almost 400 square miles, roughly the area of the five boroughs of New York City, with as many as 750,000 inhabitants. Most were rice farmers and laborers who worked the giant jigsaw of fields. In the city center, perhaps 40,000 people—elites and farmers alike—lived within the walls of Angkor Thom, a 3.5-square-mile enclosure with temples and a royal palace. Though the rainy season usually brought ample water, the ability to store water in great reservoirs called *barays* and control its flow gave Angkor an edge in times of drought or flood. But this engineered landscape required constant maintenance. When the water system faltered, so did Angkor's power.



ANGKOR'S COMPLEX PLUMBING

In Southeast Asia, months of monsoon rains are followed by months of near drought. To ensure a steady water supply, stabilize rice production, and control flooding, Khmer engineers built a network of canals, moats, ponds, and reservoirs. Massive earthworks slowed the wet-season deluge flowing from the Kulen Hills, directing it into canals that fed the barays and temple moats. Spreading across the gently sloping land, the water drained finally into the Tonle Sap, the largest freshwater lake in Southeast Asia.



ART BY STEVE COWDEN. INSET ART BY TOM CHANDLER AND MICHAEL LIM, MONASH UNIVERSITY
M. BRODY DITTEMORE AND LISA R. RITTER, NG STAFF. BASE MAP DATA BY DAMIAN EVANS, UNIVERSITY
OF SYDNEY, AND CHRISTOPHE POTTIER, FRENCH SCHOOL OF ASIAN STUDIES (EFEQ)
CONSULTANT: ROLAND FLETCHER, UNIVERSITY OF SYDNEY
SOURCES: EFEQ; GREATER ANGKOR PROJECT, A COLLABORATION OF APSARA, EFEQ,
AND UNIVERSITY OF SYDNEY
SCALE VARIES IN THIS PERSPECTIVE. LENGTH OF EAST BARAY IS 4.5 MI (7.2 KM).

Kbal
Spean

KULEN HILLS

Phnom
Dei

Siem Reap

FOREST

SACRED SOURCE

The Kulen Hills sheltered the headwaters of the Siem Reap River and were quarried for rock to build Angkor's temples. The hills were logged for timber and firewood and to clear land for farming; deforestation may have caused floods that choked some of Angkor's canals with sand and silt.

Phnom Bok

Chau Srei
Vibol

Lolei

Baray

Roluos
Group

Bakong



LIFE IN A SEA OF RICE

On raised ground between fields, Angkor residents built timber houses on stilts. They planted palms and other trees to provide shade, fruit, and fronds for annual roof replacement. Ponds collected water during the wet season; during dry months water from the main canals fed the fields. Each community had a shrine (at bottom left), where priests may have helped mediate water use.

Kompong Phluk
(modern)







Strangler fig trees and creeping lichens devour ruins at Ta Prohm, once home to hundreds of monks. To build their magnificent complexes, Angkor's feudal rulers relied on revenue generated by rice growing.



Monsoon clouds spill rain into the Srah Srang reservoir. Its guardians included lions and flame-shaped nagas, spirits trusted to bring rain. By the 16th century power shifted from Angkor toward Phnom Penh after a period of erratic monsoons.







The meditative face atop the Victory Gate at Angkor Thom likely depicts Jayavarman VII, whose rule (1181 to circa 1215) raised Angkor to a peak of wealth and power. His military successes extended Khmer rule across much of Southeast Asia.

Only kings and high priests could worship atop the hill temple of Phnom Bakheng. Now reverent silence reigns only after closing time. Sunset-viewing tourists crowd onto the platform in numbers that cause structural damage.







For centuries the coming and going of water has shaped the lives of villagers near Tonle Sap. In early July (above), before the lake rises, houses built on 20-foot stilts stand high and dry in Kompong Phluk.

Come November (right), villagers float instead of walk as the lake, home of one of the world's richest inland fisheries, brims at high water, and families easily net dinner from their porches.



(Continued from page 35) Angkor and its rulers flourished. From the era of Jayavarman II, who laid the kingdom's foundations in the early 800s, the empire's growth depended on bumper rice harvests. Throughout southern Asia, perhaps only the ancient cities of Anuradhapura and Polonnaruwa in Sri Lanka and their famed reservoirs could compare to Angkor's ability to guarantee a steady water supply.

That reliability required massive feats of engineering, including a reservoir called the West Baray that's five miles long and 1.5 miles wide. To build this third and most sophisticated of Angkor's large reservoirs a thousand years ago, as many as 200,000 Khmer workers may have been needed to pile up nearly 16 million cubic yards of soil in embankments 300 feet wide and three

stories tall. To this day the rectangular reservoir, or *baray*, is fed by water diverted from the Siem Reap River.

The first scholar to appreciate the scale of Angkor's waterworks was Bernard-Philippe Groslier, an archaeologist with the French School of Asian Studies (EFEO). In a landmark 1979 treatise, he envisioned Angkor as a "hydraulic city." The great barays, he argued, served two purposes: to symbolize the primeval sea of Hindu cosmogony and to irrigate rice fields. Unfortunately, Groslier could not pursue this concept further. Cambodia's civil war, the brutal reign of the Khmer Rouge, and the ouster of the regime by Vietnamese forces in 1979 turned Angkor into a no-go zone for two decades. After Vietnamese troops withdrew, looters descended



on Angkor, swiping statues and even chiseling off bas-reliefs.

When Christophe Pottier, an architect and archaeologist, reopened EFEO's research station at Angkor in 1992, the first priority was helping Cambodia restore dilapidated and pillaged temples. But Pottier was drawn to the wilderness beyond the temple walls. He spent months crisscrossing the southern half of Greater Angkor on motorbike and foot, mapping once hidden house mounds and shrines near artificial ponds called water tanks. (Lingering lawlessness deterred Pottier from surveying the northern half.) Then, in 2000, Fletcher and his colleague Damian Evans laid hands on NASA radar images of Angkor. They were a revelation: The University of Sydney team, working with

EFEO and APSARA, the Cambodian agency that manages Angkor, found vestiges of many more settlements, canals, and water tanks, particularly in Angkor's inaccessible areas. Donald Cooney's ultralight flights have helped Fletcher and Pottier, now a co-director of the Greater Angkor Project, examine these features in finer detail. Crucially, they found inlets and outlets to the barays, ending a debate catalyzed by Groslier's work about whether the colossal reservoirs were used solely for religious rituals or for irrigation. The clear answer is both.

The researchers were amazed by the ambition of Angkor's engineers. "We realized that the entire landscape of Greater Angkor is artificial," Fletcher says. Over several centuries, teams of laborers constructed hundreds of miles of

BAS-RELIEFS DEPICT EVERYDAY SCENES—MEN HUNCHED OVER A BOARD GAME, A WOMAN GIVING BIRTH. THEY ALSO REVEAL TROUBLE IN PARADISE.

canals and dikes that relied on subtle differences in the land's natural inclination to divert water from the Puok, Roluos, and Siem Reap Rivers to the barays. During the summer monsoon months, overflow channels bled off excess water. After the rains petered out in October or November, irrigation channels dispensed stored water. The barays may also have helped replenish soil moisture by allowing water to soak into the earth. In surrounding fields surface evaporation would have drawn up the groundwater to supply crops. "It was an incredibly clever system," says Fletcher.

That clever water system may have made the difference between mediocrity and greatness. Much of the kingdom's rice was grown in embanked fields that would otherwise have relied on monsoon rains or the seasonal ebb and flow of water on the Tonle Sap floodplain. Irrigation would have boosted harvests. The system could also have provided survival rations during a poor monsoon season, says Fletcher. And the ability to divert and impound water would have afforded a measure of protection from floods. When other kingdoms in Southeast Asia were struggling to cope with too little or too much water, he says, Angkor's waterworks would have been "a profoundly valuable strategic asset."

Thus Fletcher was baffled when his team unearthed one of the more extraordinary pieces of Angkorian workmanship—a vast structure in the waterworks—and found that it had been demolished, apparently by Angkor's own engineers.

IT'S ALMOST NOON on a June day about ten miles north of Angkor Wat, and even at the bottom of a muddy, 14-foot-long trench, there's no relief from the fierce sun. Fletcher takes off a dark blue baseball cap and wipes his brow. It looks as if the self-possessed researcher is going to launch into a precise explanation of the grayish red stone blocks his team, along with Chhay Rachna of APSARA, has unearthed. Instead,

he sighs and says, "This is simply fantastic!"

The stone blocks fitting snugly together were hewed from laterite, a spongy, iron-laden soil that hardens when exposed to air. When Fletcher and Pottier first found a section of the structure a few years ago, they thought it was the remains of a small sluice gate.

"It's turned into a monster," he says. The blocks are the remnants of a spillway across a sloping dam that may have extended as long as a football field. Around the end of the ninth century, with Angkor blossoming, engineers excavated a long canal that altered the course of the Siem Reap River, redirecting it southward to the newly constructed East Baray, a reservoir nearly as big as the later West Baray. The dam, positioned in the river, diverted water to feed the canal. But part of the massive structure may also have functioned as a spillway during monsoon surges, when water would have overtopped the low structure and flowed down the former river channel.

The ruins of the spillway are a vital clue to an epic struggle that unfolded as generations of Khmer engineers coped with a water system that grew ever more complex and unruly. "They probably spent vast portions of their lives fixing it," says Fletcher. Some of the dam's blocks lie in a jumble; huge sections of masonry are missing. "The most logical explanation is that the dam failed," Fletcher says. The river may have chewed into the dam, gradually weakening it. Perhaps it was washed away by an unusually heavy flood, the kind that comes along every century or even every 500 years. The Khmer then ripped apart much of the remaining stonework, salvaging the blocks for other purposes.

Another clue that the water system was failing comes from a pond at the West Mebon, an island temple in the middle of the West Baray. Pollen grains preserved in the muck show that lotuses and other aquatic plants flourished in the baray until the early 13th century. Then new kinds of pollen appear, from species such as ferns that prefer marsh or dry land. Right at Angkor's zenith, one of its reservoirs apparently went dry for a time. "Something was

 **Society Grant** This project was funded in part by your National Geographic Society membership.



Gamblers gather for a cockfight. A crocodile hunts for fish. A war canoe advances. Carvings at the Bayon temple record events large and small from Angkor's past.

going wrong much earlier than we expected," says Daniel Penny, a pollen expert and a co-director of the Greater Angkor Project.

Any deterioration of the waterworks would have left Angkor vulnerable to a natural phenomenon no engineer of that day could have anticipated. Starting in the 1300s, Europe endured a few centuries of unpredictable weather marked by harsh winters and chilly summers. Until recently there was only sketchy information on how other parts of the world fared during this period, called the Little Ice Age. Now it appears that Southeast Asia, too, experienced climatic upheaval.

Around Angkor, the summer monsoon season lasts from roughly May through October and delivers nearly 90 percent of the region's yearly precipitation. A dependable monsoon is critical for all manner of life, including people. To unmask monsoon patterns of long ago, Brendan Buckley of the Lamont-Doherty Earth Observatory in Palisades, New York, ventured

into the forests of Southeast Asia in search of trees with annual growth rings. He and his team knew it would not be easy: Most species in the region lack distinguishable growth rings or have ones that aren't laid down year by year. Several forays paid off with a clutch of long-lived species, including teak and *po mu*, a rare cypress. Some *po mu* trees they cataloged are nine centuries old, survivors of both Angkor's heyday and its demise.

The *po mu* trees told a stunning story. Sets of constricted growth rings showed that the trees had endured back-to-back megadroughts, from 1362 to 1392 and from 1415 to 1440. During these periods the monsoon was weak or delayed, and in some years it may



Dynasties rise and fall, but fish and rice are constants in Khmer daily life. As floodwaters ebb from a paddy field near Angkor Wat, Lao Lan sizes up his catch at a fish barrier. Not enough to sell, he says, but enough to eat.

FRITZ HOFFMANN



ANGKOR, IT APPEARS, WAS DOOMED BY THE VERY INGENUITY THAT TRANSFORMED A COLLECTION OF MINOR FIEFDOMS INTO AN EMPIRE.

have failed completely. In other years, megamonsoons lashed the region.

To a tottering kingdom, extreme weather could have been the coup de grâce. Decades earlier, Angkor's waterworks were already ailing, to judge from the idled West Baray. "We don't know why the water system was operating below capacity—it's a conundrum," says Penny. "But what it means is that Angkor really had no fat to burn. The city was more exposed to the threat of drought than at any other time in its history." Prolonged and severe droughts, punctuated by torrential downpours, "would have ruined the water system," says Fletcher.

Still, Penny says, "we're not talking about the place becoming a desert." People on the Tonle Sap floodplain south of the main temples would have been buffered from the worst effects. The Tonle Sap is fed by the Mekong River, whose headwaters in Tibetan glacier fields would have been largely immune to the effects of an altered monsoon. But Khmer engineers, skilled as they were, could not alleviate parched conditions in the north by moving Tonle Sap water against the lay of the land. Gravity was their only pump.

If inhabitants of northern Angkor were starving while other parts of the city were hoarding rice, the stage would have been set for severe unrest. "When populations in tropical countries exceed the carrying capacity of the land, real trouble begins," says Yale University anthropologist Michael Coe. "This inevitably leads to cultural collapse." A malnourished army, preoccupied with internal strife, would have exposed the city to attack. Indeed, Ayutthaya's invasion and the Khmer king's ouster happened near the end of the second megadrought.

Add to the climate chaos the shifting political

A woman named Pronh Kin receives a water blessing poured by a monk to bring luck and health. Such benedictions served kings and commoners alike in the glory days of Angkor.

and religious winds already buffeting the kingdom, and Angkor's fate was sealed, says Fletcher. "The world around Angkor was changing. Society was moving on. It would have been a surprise if Angkor persisted."

The Khmer Empire was not the first civilization felled by climate catastrophe. Centuries earlier, as Angkor was rising, halfway around the world a similar loss of environmental equilibrium was hammering the Maya city-states in Mexico and Central America. Many scholars now believe that the Maya succumbed to overpopulation and environmental degradation following a series of three punishing droughts in the ninth century. "Essentially, the same thing happened to Angkor," says Coe, who in the 1950s was the first to discern similarities between the Khmer and Maya civilizations.

Modern societies may need to brace for similar climatic challenges. According to Buckley, the most likely trigger of the Angkor megadroughts was intense and persistent El Niño warming of the surface waters of the central and eastern tropical Pacific Ocean. Scientists debate whether human-caused climate change will lead to more pronounced El Niños, but the Vietnamese tree rings show that even natural oscillations in the Pacific can spark catastrophe.

Angkor's end is a sobering lesson in the limits of human ingenuity. The Khmer had transformed their world—a monumental investment that would have been excruciating for the kingdom's rulers to forsake. "Angkor's hydraulic system was an amazing machine, a wonderful mechanism for regulating the world," Fletcher says. Its engineers managed to keep the civilization's signal achievement running for six centuries—until, in the end, a greater force overwhelmed them. □



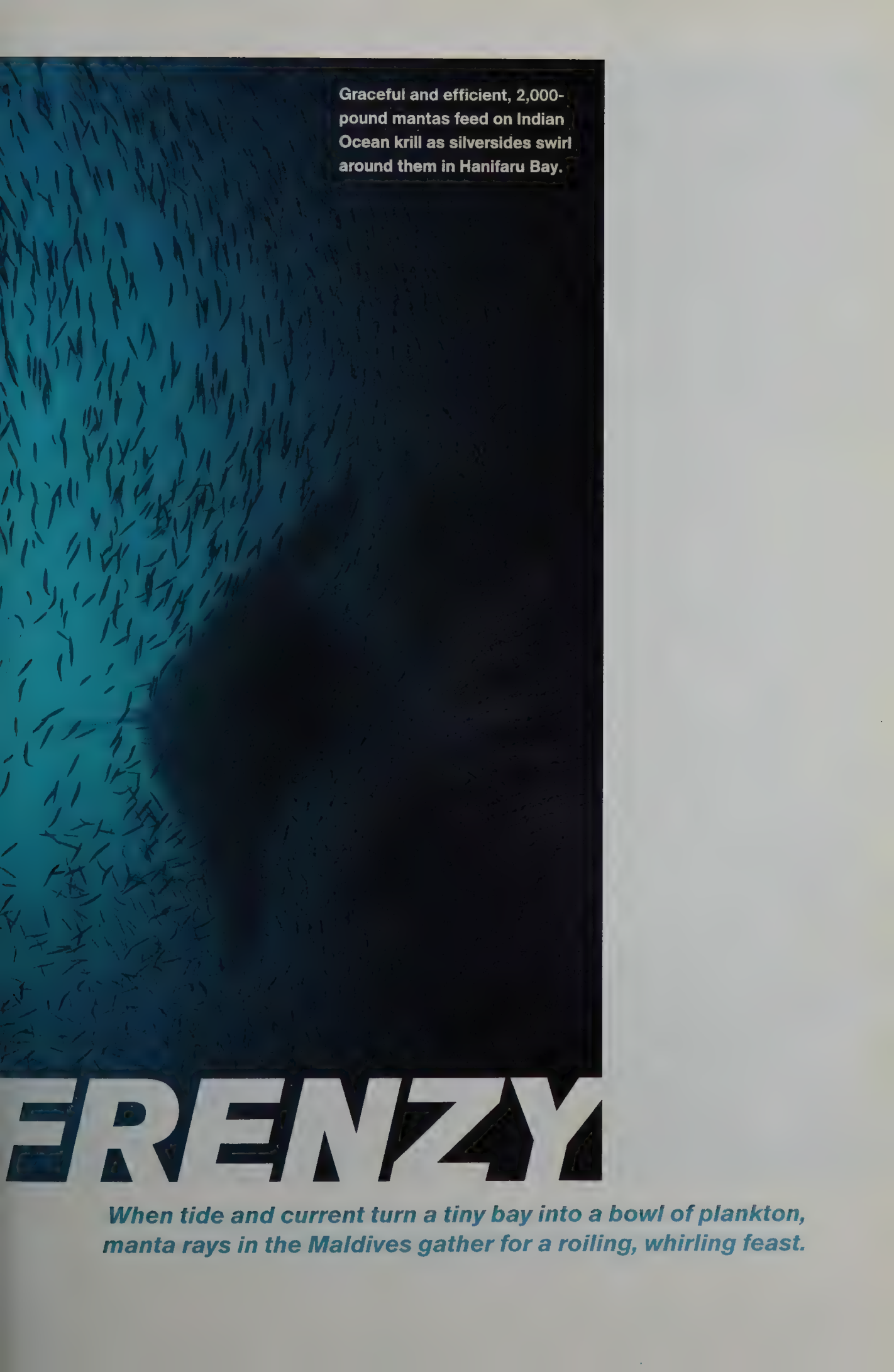
Learn how long-ago canals and reservoirs might have kept water flowing. See *Secrets of Angkor* on the **National Geographic Channel**, July 14 at 9 p.m. ET in the U.S.

Fly over Angkor Wat—and dive down for a closer look—at ngm.com.





FEEDING



Graceful and efficient, 2,000-pound mantas feed on Indian Ocean krill as silversides swirl around them in Hanifaru Bay.

ERENZY

When tide and current turn a tiny bay into a bowl of plankton, manta rays in the Maldives gather for a roiling, whirling feast.





Like an aquatic vacuum cleaner, a manta thrusts forward to capture plankton. Frontal cephalic fins channel water into the mouth, where plankton are trapped in sieves of spongy tissue between riblike gill rakers.

BY BRUCE BARCOTT

PHOTOGRAPHS BY THOMAS P. PESCHAK

Four hundred forty miles off the southern coast of India, in the archipelago nation of the Maldives, there is an uninhabited island named Hanifaru. It's not much to see from the air: a spray of tropical shrubs on what appears to be a truckload of sand. Hanifaru is so small a child could walk its entire scimitar-shaped coastline in a ten-minute stroll. The island's size isn't unusual for the Maldives, a collection of 1,192 tiny islands clumped in 26 atolls encompassed by the vastness of the Indian Ocean. But several times a year, when time and tide align, manta rays from throughout the Maldives converge here to feed in a spectacular coral-reef ballet.

From May through November, when the lunar tide pushes against the Indian Ocean's southwestern monsoon current, a suction effect pulls tropical krill and other plankton from deep water up to the surface. The current sweeps the krill into the cul-de-sac of Hanifaru Bay. If the krill stayed at the surface, they'd wash over the bay's coral walls and out to the safety of the open sea. But they can't. Instinct forces them to dive away from daylight. When they do, they get trapped deep in the bowl. In just a few hours a massive concentration of plankton builds up, a swarm so thick it turns the water cloudy.

Cue *Manta birostris*. "Just after high tide you'll see a few manta rays turn up," says Guy Stevens, a British marine biologist who's been researching the Maldives mantas for the past three years. "Then *poof*, a whole group will move in, and you'll get as many as 200 feeding for two to four hours in a bay no bigger than a soccer field."

These massive fish (the wingspans of Maldives mantas can reach 12 feet) are dynamic filter feeders, shoveling their shoe-box mouths through krill like threshers through wheat, inhaling prey. They barrel roll when they hit a rich patch, somersaulting backward to stay in the hot spot. They chain feed, following each other in a train of open maws.

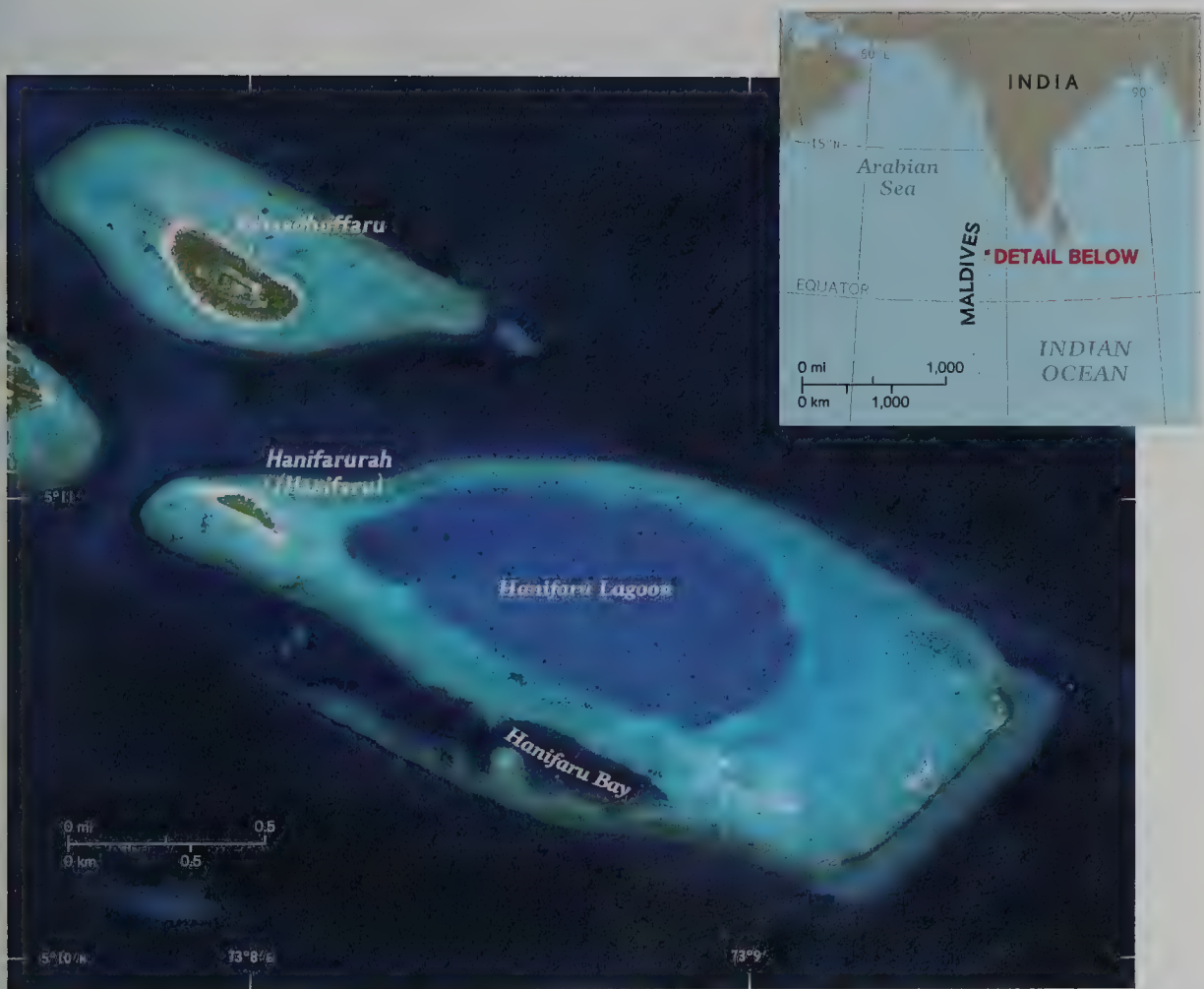
In the tight confines of Hanifaru Bay, mantas must expand their repertoire, and Stevens has identified maneuvers rarely seen by scientists. When 50 or more fish chain feed in the bay, something extraordinary happens. The head of the line catches the tail, and the chain spins into a vortex. "We call that cyclone feeding," says Stevens. "When you get more than a hundred mantas doing that, they start to spiral out. When the chain breaks down, you get chaos feeding." The stately dance in the milky waters turns into a free-for-all, with hundreds of mantas bumping into each other. Adding to the confusion are whale sharks—languid, plankton-eating giants, each about the size of a 40-foot shipping container—that show up to share the spoils. Within hours the plankton run out, the feast winds down, and the mantas plow the bay's sandy bottom with their cephalic fins to throw hidden prey back into the water column.

Generations ago those hornlike cephalic fins earned mantas the name devilfish. Their terrifying size and bat shape fed an aura of mystery and menace, and mantas were vilified as ferocious monsters. That changed in the 1970s, when scuba divers found mantas to be gentle creatures. Sometimes they even permitted humans to catch joyrides on their broad backs.

Because of their accommodating nature, mantas today have achieved the dubious status of dive-tourism attractions, luring humans to swim with them in closer-than-optimum quarters. For a species considered near threatened, however, this newfound popularity could literally be a lifesaver. Mantas, with their slow reproductive rate, are vulnerable to overfishing, so a robust tourist trade could give local communities an economic incentive to conserve the fish rather than kill them. It's a delicate balance, though—too many humans could drive mantas out of feeding grounds like Hanifaru Bay.

To avoid that, Stevens has proposed turning the bay into a marine sanctuary. A new Maldives president has vowed to strengthen the archipelago's marine protections, but his government has so far been slow to respond to Stevens's idea. "I'm not ruling out declaring Hanifaru a

Bruce Barcott covered the wildlife of Svalbard, Norway, in our April issue. Thomas Peschak is chief photographer for the Save Our Seas Foundation.



The elongated scoop of Hanifaru Bay (above) collects plankton, mantas, and flocks of tourists who come to swim with mantas. Guy Stevens, a biologist with the Save Our Seas Foundation, worries that crowds, and lax enforcement of marine-protection laws, threaten the fish's safety.

marine-life sanctuary. But we need to increase our ability to enforce existing environmental laws before creating new protected areas," says Environment Minister Mohamed Aslam.

Meanwhile, scientific knowledge about mantas remains surprisingly thin. Only last year a leading expert proposed splitting the species in two: smaller resident mantas, like those in the Maldives that remain near shore, and larger transient mantas (with wingspans as great as 22 feet) that roam the world's tropical and semi-tropical oceans. And researchers are just beginning to learn more about those cephalic fins. "When you approach a manta, it will unroll a cephalic fin and wave it back and forth as if it's scanning," says Robert Rubin, a California-based marine biologist who's studied mantas in Mexico for 20 years. "Mantas are essentially flat sharks,

and we know some sharks have electrical receptors in their faces. The hypothesis is that mantas use those fins to pick up electrical signals from other animals moving in the water."

In the Maldives, Stevens continues to catalog the local animals. (He's identified more than 1,500 individuals by their unique spot patterns.) His data also record the exact timing of the feedings, information that would be of great value to the local guide industry. Stevens hears the clock ticking, and he is scrambling to organize a self-policing regime among resorts and local guides before dive tourists overrun Hanifaru. "We don't want to ruin what we've got here," he says. If his plan works, Hanifaru Bay will remain a sanctuary for cyclone-feeding manta rays, with just enough room for whale sharks, and humans as well. □





Mantas and whale sharks commonly feed together (left), untroubled by the occasional collision. As many as 200 rays and a half dozen whale sharks have been counted in a period of several hours, Stevens reports. When the plankton soup turns thin, mantas work the sandy bottom (above) with their cephalic fins to stir any hidden prey up into the water column.





As plankton swarms accumulate, mantas come to feast. The total Maldives population is estimated at 10,000 individuals. Three are following one behind another, chain feeding (at left). These mantas may soon swirl into a spiral formation for cyclone feeding—behavior rarely seen outside of Hanifaru Bay.

ROOMFULS OF TOTAL STRANGERS UNDER

MASS HYPNOSIS!

THE WORLD'S LARGEST AND MOST POLITE

CORN DOG CHOMP!

FARM ADOLESCENTS WELL VERSED IN

ANIMAL HUSBANDRY!

MOTHERS WHO LOOK LIKE DAUGHTERS

AND VICE VERSA!

CANDY APPLES, PORK CHOPS ON A STICK, AND

FRIED COCA-COLA!

YOUNG MEN WHO WANT YOU TO BECOME A

CAREER BEAUTICIAN!

TAKE IN THE STATE FAIR WITH

GARRISON KEILLOR

PHOTOGRAPHS BY

JOEL SARTORE



Sabra Jackson and her calf Princess took honors at the Indiana State Fair.





"I ain't got no body," croons Andy Mullins, midway barker at the State Fair of Texas.

"I greet people, crack 'half' jokes, sing 'All of Me,'" he says. But the mirror illusion that makes him look like half a man is the big draw. "I love the way kids look at me and ask if I'm real."



Eating into history, 8,400 Iowa fairgoers bite in synchrony at the first-ever Corn Dog Chomp, in 2008. Recipes vary (bacon fat makes some extra tasty), but corn dogs have been fair fare since at least the 1940s. A new treat debuted in Texas in 2006: fried Coca-Cola (batter balls flavored with cola syrup).



THE STATE FAIR is a ritual carnival marking the end of summer and gardens and apple orchards and the start of school and higher algebra and the imposition of strict rules and what we in the north call the Long Dark Time. Like gardening, the fair doesn't change all that much.

The big wheel whirls and the girls squeal and the bratwursts cook on the little steel rollers and the boys slouch around and keep checking their hair. It isn't the World's Columbian Exposition, the Aquarian Exposition, the Great Exhibition of the Works of Industry of All Nations, the Exposition Universelle, the Gathering of the Tribes, or the Aspen Institute. It's just us, taking a break from digging potatoes.

The Ten Chief Joys of the State Fair are:

1. To eat food with your two hands.
2. To feel extreme centrifugal force reshaping your face and jowls as you are flung or whirled turbulently and you experience that intense joyfulness that is indistinguishable from anguish, or (as you get older) to observe other persons in extreme centrifugal situations.
3. To mingle, merge, mill, jostle gently, and flock together with throngs, swarms, mobs, and multitudes of persons slight or hefty, punky or preppy, young or ancient, wandering through the hubbub and amplified razzmatazz and raw neon and clouds of wiener steam in search of some elusive thing, nobody is sure exactly what.
4. To witness the stupidity of others, their gluttony and low-grade obsessions, their poor manners and slack-jawed, mouth-breathing, pop-eyed yahootude, and feel rather sophisticated by comparison.
5. To see the art of salesmanship, of barking, hustling, touting, and see how effectively it works on others and not on cool you.
6. To see designer chickens, the largest swine, teams of mighty draft horses, llamas, rare breeds of geese, geckos, poisonous snakes, a two-headed calf, a 650-pound man, and whatever

else appeals to the keen, inquiring mind.

7. To watch the judging of livestock.
8. To observe entertainers attempt to engage a crowd that is moving laterally.
9. To sit down and rest amid the turmoil and reconsider the meaning of life.
10. To turn away from food and amusement and crass pleasure and to resolve to live on a higher plane from now on.

THE MIDWEST is State Fair Central, and it thrives here because we are the breadbasket of America, Hog Butcher, Machinemaker, Stacker of Particleboard, Player With Chain Saws, Land of the Big Haunches. And also because Midwesterners are insular, industrious, abstemious, introspective people skittish about body contact, and a state fair is liberation from all of that, a plunge into the pool of self-indulgence, starting with a thick pork chop hot off the grill and served on a stick with a band of crisp brown fat along one side. The fat is not good for you. You eat the pork chop, fat and all, and your child eats her pork chop, and then you score a giant vanilla shake from the Dairy Bar to cushion the fall of a bagful of tiny doughnuts. Now you're warmed up and ready to move on to the corn dog course.

But first here is a flume ride your child is agitating for, so you climb onto a steel raft and plunge into a concrete gorge and over a waterfall, and a two-foot wave washes over the gunwales, and now your pants are soaked. You disembark. You look like a man who could not contain his excitement. For cover, you hide in the crowd. You walk close behind people. You join the throng at the hot-corn stand and comfort yourself with a salty ear of buttered corn. Your pants chafe. You wander among booths of merchandise looking for men's pants and find

Garrison Keillor's Rhubarb Tour visited six state fairs in 2008. Meanwhile, photographer Joel Sartore energized his coverage with at least 30 corn dogs.



Lou Plocher's double somersault with a half twist into eight feet of water, from 80 feet up, leaves Nebraskans gasping. Here he's a funnyman in pirate garb, but some days he dives while on fire. After thousands of plunges and two broken feet, he says, "it's still a rush."

encyclopedias, storm windows, lawn mowers, vegetable peelers and choppers, humidifiers, log splitters, and home saunas. Your search for dry pants leads you through buildings where champion jams and jellies are displayed on tables draped with purple, blue, red, yellow ribbons, and also champion cakes (angel food, Bundt light, Bundt dark, chiffon, chocolate, chocolate chiffon, German chocolate, jelly roll, pound, spice, sponge, vegetable, or fruit) and pickles (beet, bean, bread-and-butter, cucumber sweet, dill without garlic, dill with garlic, peppers sweet, peppers hot, watermelon). And through an education pavilion where headhunters lie in wait for you to pause and make eye contact, and they leap on you and make you hear about the benefits of beautician training, the opportunities in the field of broadcasting.

The way to dry out your pants is to get on a

motorized contraption that whirls you through the air. Your child suggests you ride the giant Slingshot that is across the street. A long line of dead-end kids wait to be strapped into a cage and flung straight up in the air. The mob of onlookers waiting for the big whoosh looks like the crowds that once gathered to watch public executions.

You pass up the Slingshot for the double Ferris wheel. An excellent clothes dryer, lifting you up above the honky-tonk, a nice breeze in your pants, in a series of parabolas, and at the apex you look out across the gaudy uproar and the blinking lights, and then you zoom down for a close-up of a passing gang of farm boys in green letter jackets and then back up in the air. You tell your child that this Ferris wheel is the ride that, going back to childhood, you always saved for last, and so riding it fills you with nostalgia. She pats your hand. "You'll be all right, Dad,"

THE YOUNG PEOPLE LEADING COWS AROUND THE SHOW RING ARE RELATIVES OF ABRAHAM AND JOB. YOU COULD LEARN SOMETHING FROM THEM.

she says. After ten minutes you come down nice and dry, and also the food has settled in your stomach, and you're ready for seconds.

OF THE TEN JOYS, the one that we Midwesterners are loath to cop to is number three, the mingling and jostling, a pleasure that Google and Facebook can't provide. American life tends more and more to put you in front of a computer screen in a cubicle, then into a car and head you toward home in the suburbs, where you drive directly into the garage and step into your kitchen without brushing elbows with anybody. People seem to want this, as opposed to urban tumult and squalor. But we have needs we can't admit, and one is to be in a scrum of thinly clad corpulence milling in brilliant sun in front of the deep-fried-ice-cream stand and feel the brush of wings, hip bumps, hands touching your arm ("Oh, excuse me!"), the heat of humanity with its many smells (citrus deodorant, sweat and musk, bouquet of beer, hair oil, stale cigar, methane), the solid, big-rump bodies of Brueghel peasants all around you like dogs in a pack, and you—yes, elegant you of the refined taste and the commitment to the arts—are one of these dogs. All your life you dreamed of attaining swanhood or equinity, but your fellow dogs know better. They sniff you and turn away, satisfied.

Some state fairs are roomier, some gaudier, but there is a great sameness to them, just as there is a similarity among Catholic churches. No state fair can be called trendy, luxurious, dreamy—none of that. Nothing that is farm oriented or pigcentric is even remotely upscale.

Wealth and social status aren't so evident at the fair. The tattooed carnies who run the rides have a certain hauteur, and of course if you're on horseback, you're aristocracy, but otherwise not. There is no first-class line, no concierge section roped off in the barns. The wine selection is white, red, pink, and fizzy. Nobody flaunts his money.

The state fair, at heart, is an agricultural expo, and farming isn't about getting rich, and farmers discuss annual income less than they practice nude meditation on beaches. Farming is about work and about there being a Right Way and a

Wrong Way to do it. You sit in the bleachers by the show ring and see this by the way the young women and men lead their immaculate cows clockwise around the grumpy, baggy-pants judge in the center. They walk at the cow's left shoulder, hand on the halter, and keep the animal's head up, always presenting a clear profile to the judge's gaze, and when he motions them to get in line, the exhibitors stand facing their cows and keep them squared away.

You and I may have no relatives left in farming, and our memory of the farm, if we have any, may be faint, but the livestock judging is meaningful to us—husbandry is what we do, even if we call it education or health care or management. Sport is a seductive metaphor (life as a game in which we gain victory through hard work, discipline, and visualizing success), but the older metaphor of farming (life as hard labor that is subject to weather and quirks of blind fate and may return no reward whatsoever and don't be surprised) is still in our blood, especially those of us raised on holy scripture. The young men and women leading cows around the show ring are relatives of Abraham and Job and the faithful father of the prodigal son. They subscribe to the Love Thy Neighbor doctrine. They know about late-summer hailstorms. You could learn something from these people.

TWILIGHT FALLS on the fairgrounds, and a person just suddenly gets sick of it all. You've spent hours gratifying yourself on deep-fried cheese curds, deep-fried ice cream, testing one sausage against another, washing them down with authentic American sarsaparilla, sampling your child's onion rings, postponing the honey sundae for later, and now it is later, and the horticulture building and the honey-sundae booth are four blocks and a river of humanity away. You and the child stand at the entrance to the midway, barkers barking at you to try the ring-toss, shoot a basketball, squirt the water in the clown's mouth and see the ponies run, win the teddy bear, but you don't want to win a big blue plush teddy bear. You have no use for one whatsoever. There is enough inertia in your life as



Like mother, like daughter. The Look-alike Contest is an Iowa fair Rural Americana Olde Tyme event. Pairs are judged not just on matching faces but also voice, walk, and mannerisms. Pair 239 (at far right) took second; 251, sixth. Top prize: A blue ribbon, five bucks, and bragging rights.

it is. And now you feel the great joy of revulsion at the fair and its shallow pleasures, its cheap tinsel, its greasy food. You are slightly ashamed of your own intake of animal fats. Bleaugh, you think. Arghhhh. OMG. You have gone twice to ATMs to finance this binge, and you regret that. No more of this! You take the child's hand. There will be no honey sundae tonight, honey. We got all that out of our system. We are going home and sober up and get busy.

You hike toward where you recollect you parked your car this morning, and by a stroke of God's grace you actually find it, and your child does not have to watch a father roaming around pitifully, moaning to himself. You get in, and you drive back to the world that means something, the world of work. The Long Dark Time is coming, and you must gather your herds to shelter and lay in carrots and potatoes in the cellar.

The fair is gone the next day, the rides disassembled, the concessions boarded up, the streets swept clean. Dry leaves blow across the racing oval, brown squirrels den up in the ticket booths, the midway marquee sways in the wind. You drive past the fairgrounds a few days later on your way to work. It looks like the encampment of an invading army that got what booty it wanted and went home. And now you are yourself again, ambitious, disciplined, frugal, walking briskly, head held high, and nobody would ever associate you with that shameless person stuffing his face with bratwurst and kraut, mustard on his upper lip, and a half-eaten deep-fried Snickers in his other hand. That was not the real you. This is. This soldier of the simple declarative sentence. You have no need for cheap glitter and pig fat and pointless twirling. You have work to do. Onward. □



Some 470 hooved entrants paraded by judges during Minnesota's 4-H dairy cattle show in 2008, with seven major breeds competing in more than a dozen age groups. Points for qualities such as udder fullness, body angularity, and stride add up to coveted awards.





Fun for all ages! Minnesota sisters Bridgit and Bergen Flom (above) sport big rainbow dos styled for \$14 each and a buck for glitter. Iowa's derby stunts (below) are always a blast: Gregory "Dr. Danger" Carpenter performed the Suicide Car Jump—a 50-foot, 60 mile-an-hour leap from a flaming ramp into a four-stack of junked cars—38 times last year, with three hospital trips and no life or health insurance. Despite cracked bones and burns, "I squeak by each time," he says.





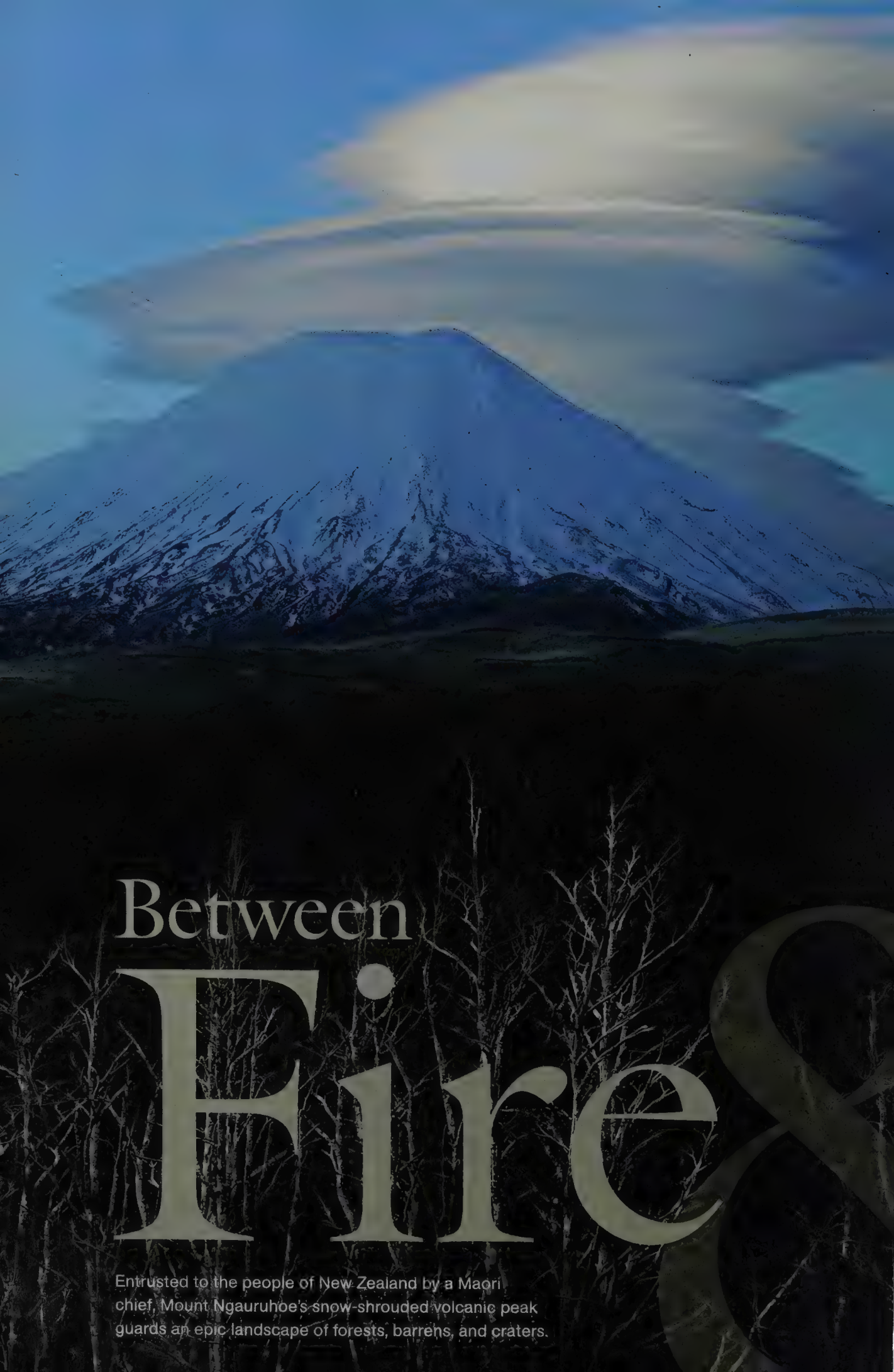
Indiana has Madagascar hissing roaches (above) that pull tiny tractors bearing flags of rival universities without a whit of training, brags Purdue University roach wrangler Tom Turpin. And who can resist group hypnosis? Iowa volunteers go catatonic (below) at the snap of hypnotist Ron Diamond's fingers. Next he may tell them to wiggle or scratch. "I create an environment that lets the subconscious work, then make suggestions," Diamond says. "The mind does wonderful things, if we let it."





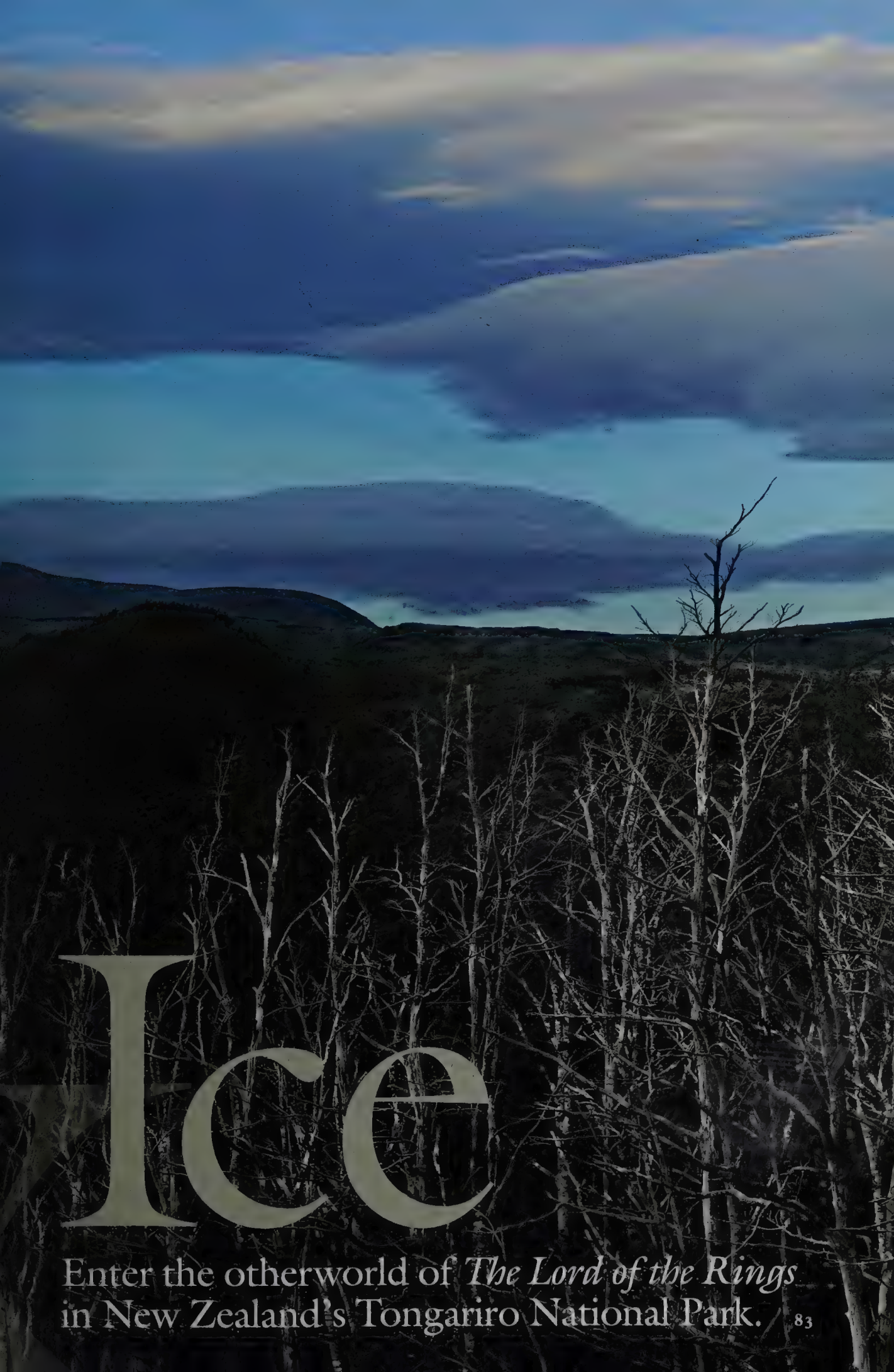
When you're slammed through the night sky at 75 miles an hour and 4 g's, "your stomach stays on the ground," says Minnesota fairgoer Tim Petersen. Reluctant at first, he and Deborah Smith finally succumbed to the Slingshot's 200-foot launch and free fall to Earth. Go again? "Definitely."





Between Fire

Entrusted to the people of New Zealand by a Maori chief, Mount Ngauruhoe's snow-shrouded volcanic peak guards an epic landscape of forests, barrens, and craters.



Ice

Enter the otherworld of *The Lord of the Rings*
in New Zealand's Tongariro National Park.





A volcanic boulder rests above Upper Tama lake, a crater below Mount Ngauruhoe. The volcano has exploded more than 70 times since 1839. Throughout the park, officials urge visitors to know likely paths of volcanic mudflows and to leave when eruption threatens.

BY MEL WHITE

PHOTOGRAPHS BY STUART FRANKLIN

As you contemplate the heart of
Tongariro National Park—
three peaks that rise in one of
the most beautiful places in the
famously beautiful country of New Zealand—

you may well find questions of aesthetics intruding on your appreciation of the spectacular scene before you.

To the south looms the craggy mass of Ruapehu, at 9,176 feet the tallest peak on the North Island. Built by 250,000 years of volcanism, it's still active today—waking every few years to send up enormous columns of steam and ash. To the north is Tongariro, even older, a sprawling complex of ancient craters where vents continuously and ominously exhale sulfurous clouds.

In the middle stands Ngauruhoe. Less massive than its companions, Ngauruhoe (Mount Doom in Peter Jackson's *Lord of the Rings* film trilogy) forms a wondrously symmetrical cone, capturing your attention with the simple perfection of its form. The mountain lacks only a few streaks of vivid red crayon above it to be every child's drawing of the archetypal volcano.

What (you ask yourself) is this anomalously sensual shape doing in such a rough neighborhood? And further: What does it mean that you're so irresistibly attracted to it?

"Age, I do abhor thee; youth, I do adore thee," the Bard wrote, and there you have it—an explanation and a justification, if you need one. This peak was born just a couple thousand years ago. The Ice Age glaciation that tore and scarred Ruapehu and Tongariro happened long before Ngauruhoe was born. Rain and fiery explosions have not yet marred its face. In the geological world, too, the beauty of youth works its seductive power.

The Maori, New Zealand's indigenous people, look on all three volcanoes with awe and consider them *tapu*, a word whose diverse meanings include both "sacred" and "sanctity." When Europeans began settling the central North Island in the mid to late 19th century, dividing the land into towns and farms, the Maori feared for the integrity of the peaks. The paramount chief, Horonuku, or Te Heuheu Tukino IV, came up with a farsighted solution: He transferred the volcanoes' *tapu* from himself to Queen Victoria, and in 1887 he entrusted the mountains and the land within a mile of their summits to the government and people of New Zealand. The tract became the country's first national park and has grown to the current 194,270-acre protected area.

Mel White's last story was "Path of the Jaguar," in March 2009. Stuart Franklin is currently working on projects in the United Kingdom.



Maori tapu explains why Tongariro holds the rare distinction of having twice been named a World Heritage site, both for its physical features and, later, for its cultural importance. The park's fire-and-ice combination of active volcanoes and glaciers easily won it the natural-heritage status of sites such as the Great Barrier Reef and the Everglades. But the United Nations committee that decides such matters originally turned down New Zealand's proposal to accept Tongariro as a cultural site, having previously given that rank only to human-built sites (think of Chartres Cathedral and the Egyptian pyramids). After a new presentation from a delegation including Maori elders, though, Tongariro in 1993 became the first site in the world to receive heritage status under a new criterion called associative cultural landscapes, for the terrain's spiritual importance to indigenous people.

THE 12-MILE-LONG TRAIL called the Tongariro Alpine Crossing begins in tussock grassland, then climbs past lava cliffs and glacial moraines (heaps of debris piled up by former glaciers) to the base of Ngauruhoe, where hikers willing to endure a couple of hours trudging up scree can make a side trip to the top of the volcano. The

Oxidized iron and volcanic debris surround one of the Emerald Lakes on Mount Tongariro. Visitors swim in the park's mineral-tinted lakes, in spite of the water's sulfurous scent.

main route ascends the slopes of Tongariro to the top of Red Crater. Steaming like the gate to hell, Red Crater is named for the rock around its mouth, given a chestnut hue by oxidized iron. Surrounding swaths of black lava testify to the crater's long history of eruptions, continuing through the late 1800s.

On the downslope from Red Crater, three lakes fill explosion pits stained by minerals in shades of emerald that gave them the Maori name Ngarotopounamu. Soon after, the crossing passes another lake, Te Wai-whakaata-o-te Rangihiroa, or Blue Lake. Indeed, on a clear day its water seems torn from the sky above. The trail then descends grassy hillsides and passes steaming volcanic vents to finish in dense forest along a tumbling stream called Mangatipua.

On the southwestern slope of Ruapehu, ancient woodlands of a different sort survive by a quirk of geography. The great bulk of Ruapehu sheltered this forest from the massive Taupo volcano blast of A.D. 186, while trees for miles in all other



LORDS OF THE RING OF FIRE

Tongariro lies on the Ring of Fire—the dynamic seismic zone that encircles the Pacific Ocean. Just off the North Island of New Zealand, one tectonic plate dives beneath another at a subduction zone (below), their clash helping fuel the fires of the three active volcanoes that consume and rebuild the park. These daunting summits and the surrounding eruption-blasted terrain served as director Peter Jackson's realm of evil darkness in his *Lord of the Rings* films. Guidebooks leading movie fans to landscapes featured in the trilogy have become major nonfiction best sellers in New Zealand, as “Middle Earth” tourism adds to Tongariro's allure.



directions were flattened. An easy trail winds under soaring rimu, matai, and kahikatea trees laden with ferns, while below, tree ferns spread their lacework fronds, and kamahi trees seem to be frozen in the throes of a hula-like dance.

This lushness, like Tongariro's innumerable rocky streams and waterfalls, is fed by clouds that drift from the Tasman Sea to release their moisture against the mountain slopes. In the North Island's highlands you'll have ample opportunity to perfect your own definitions of fog, mist, drizzle, sprinkle, light rain, and rain, and the subtle distinctions among them.

COEXISTING WITH TONGARIRO'S BEAUTY are serious conservation and cultural issues. Like the rest of New Zealand, the park's ecosystem suffered terrible losses from the introduction of alien species, from rats brought by the earliest Maori to rabbits, stoats, Australian possums, and cats brought by Europeans. Native birds, which evolved without mammalian predators for millions of years, were devastated and survive today at only a fraction of their former numbers. Even as the kiwi, the bizarre, flightless bird, became the beloved symbol of New Zealand, it almost died out in the wild, its eggs and young devoured by stoats.

Plants, too, cause problems for park managers. An early ranger introduced grouse from Britain as game and brought heather to feed them. The grouse died out, but heather spread as a lavender-hued plague, displacing native vegetation over wide areas. Lodgepole pine came from North America as a timber tree; its wind-borne seeds carry far beyond plantations, making it exceedingly difficult to eradicate.

Only the widespread use of traps and poisons to fight intruders has prevented the decline of species such as the rare blue duck, which still inhabits Tongariro streams; the parrot known by the Maori name *kaka*; and the absurdly fearless little New Zealand robin, which hops around the boots of hikers, searching for insects in leaves stirred by their footsteps. Thanks to

intensive poisoning and a program of raising chicks in captivity until they can defend themselves, the kiwi's eerie whistling calls still echo through Tongariro's woodlands, thrilling those who venture out along trails on quiet nights.

Incongruously, the North Island's most popular ski areas sit on the three slopes of Ruapehu, with their associated shops, lifts, and roads. No such blatantly commercial development would be allowed in a national park today, but the ski runs date from 1913 and, for better or worse, attract a half million visitors a season. Department of Conservation (DOC) staffers constantly try to find compromises in park management that will keep skiers satisfied while protecting one of the planet's most wondrous places.

Decisions about Tongariro's safekeeping have grown ever more complex. In recent decades Tongariro's Maori neighbors, the indigenous *iwi* (Maori communities)—long excluded from such matters by the ruling Pakeha (people of European ancestry)—have regained political rights and influence. Some believe that Te Heuheu—who was, after all, chief only of the Ngati Tuwharetoa tribe—had no right to give away the three volcanic peaks on behalf of all Maori and would like to reclaim the park as sacred tribal land. Others, less radical, would close the mountaintops to climbers or restrict access to those accompanied by a local Maori guide.

Bird-eating stoats, parking-lot construction, profound spiritual and cultural values—all these issues crowd the desks of DOC managers. And one more: Theoretically at least, the park could blow itself to smithereens at any moment.

A visitor can put these concerns out of mind for a while—long enough for a hike that in a single day can encompass barren volcanic rock and rich, complex forest, the sound of waterfalls and the whoosh of native pigeons' wings, the smells of sulfur from deep underground and of moss and ferns and earth after rain. And above it all, the sight of the three great peaks of Ruapehu, Ngauruhoe, and Tongariro, the creators and destroyers of this land. □

Tongariro holds the distinction of having
twice been named a World Heritage site,
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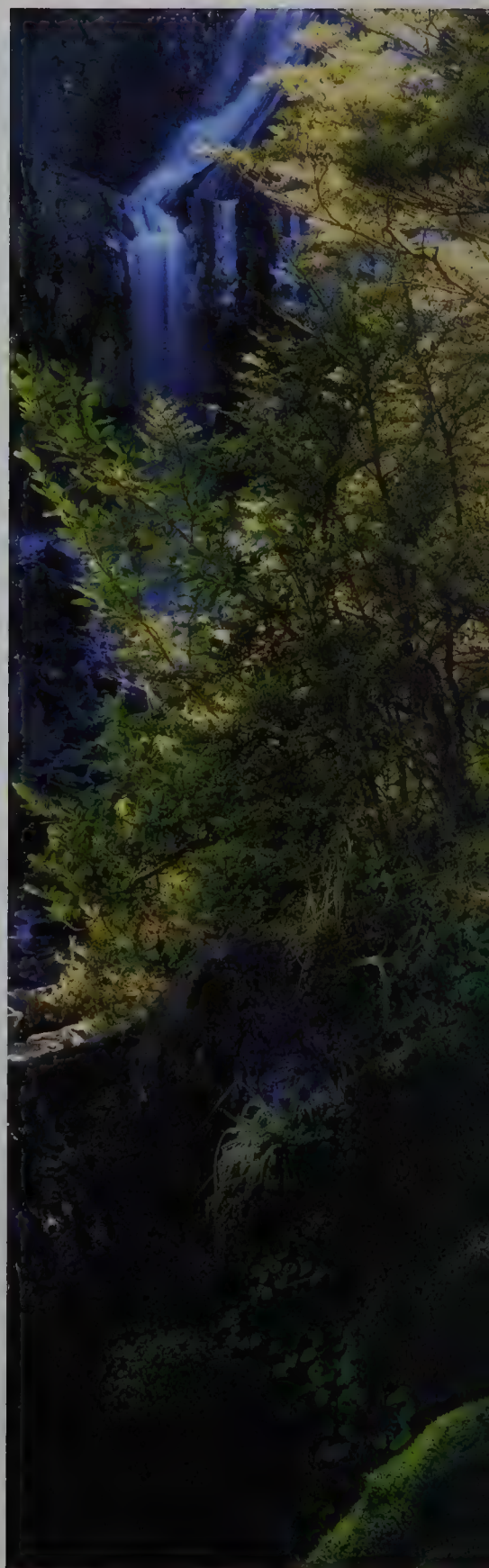


Emerald Lakes stairstep up Tongariro's infernal slopes, in cool contrast to the steaming, cinder-strewn terrain. Some 65,000 visitors hike the 12-mile Tongariro Alpine Crossing each year.

PANORAMA COMPOSED OF THREE IMAGES



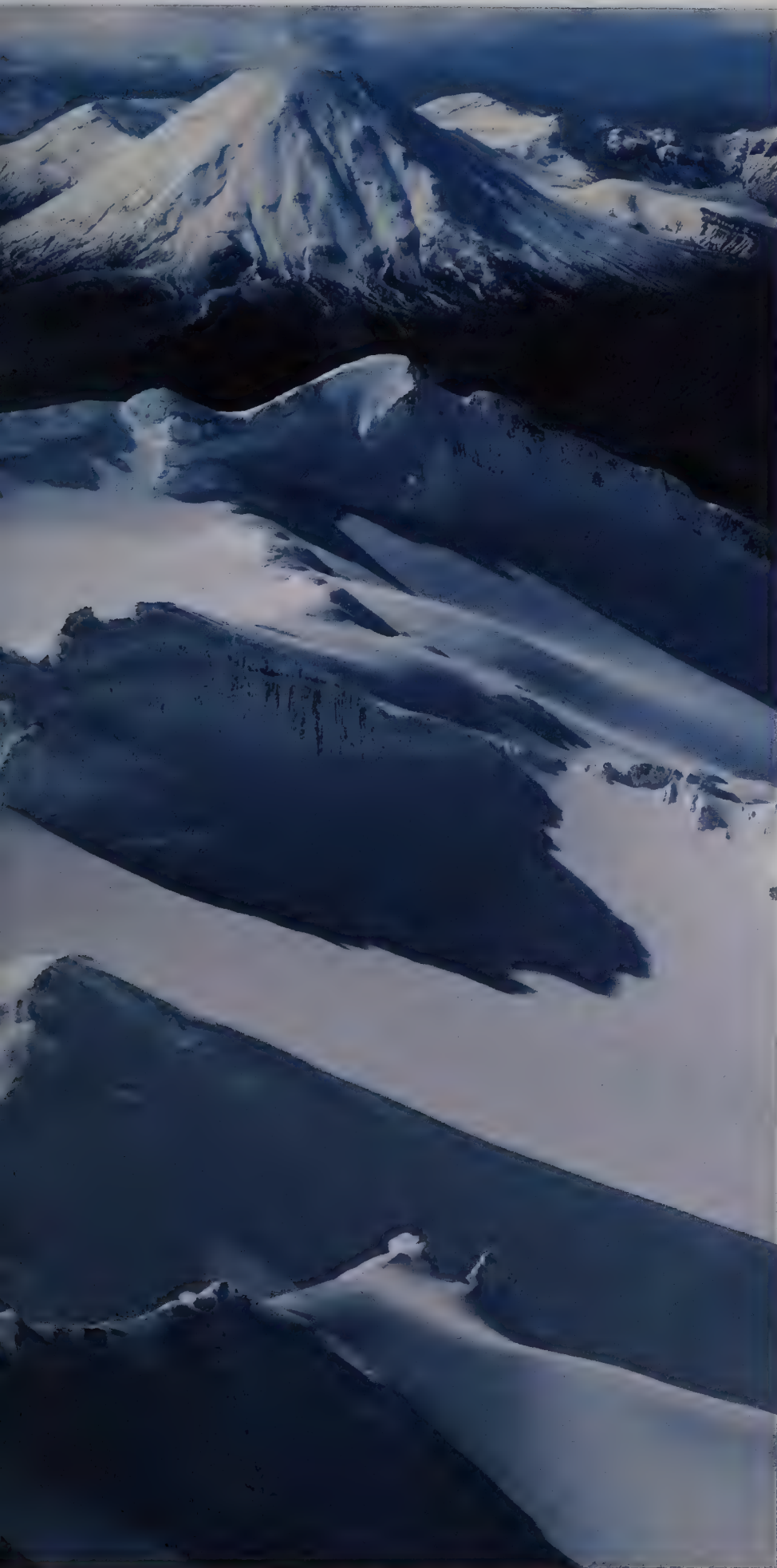
Tranquil beech forests cloak Waitonga Falls as it tumbles 128 feet down the southern flank of Mount Ruapehu. Because the park's volcanoes stand fully exposed to the Tasman Sea, westerly winds wrap around their summits, bringing heavy rainfall. Water cascades down nearly every gully and gorge, seeking the Central Plateau or the sea. National symbol of New Zealand, tree ferns can grow to 20 feet, catching the mist on graceful fronds (above).





This lushness, like Tongariro's innumerable
rocky streams and waterfalls, is fed by clouds
that drift from the Tasman Sea.





Mantled in winter white, 9,176-foot-tall Mount Ruapehu (foreground) reigns over Tongariro National Park. Conical Ngauruhoe and broad Tongariro beyond shed their snow cover when summer comes, but the cold lock on Ruapehu never breaks, making Crater Lake one of the most active volcanic crater lakes perpetually surrounded by snow and ice in the world.





ONE THE NATION SERBS DIVISIBLE

Right-wing nationalist Serbs march in Belgrade under the banner of Radovan Karadzic, who is charged with war crimes. Today's Serbs are torn between a wish—rooted in their history—to unite their scattered people and a desire to join Europe, accepting a diminished Serbia.

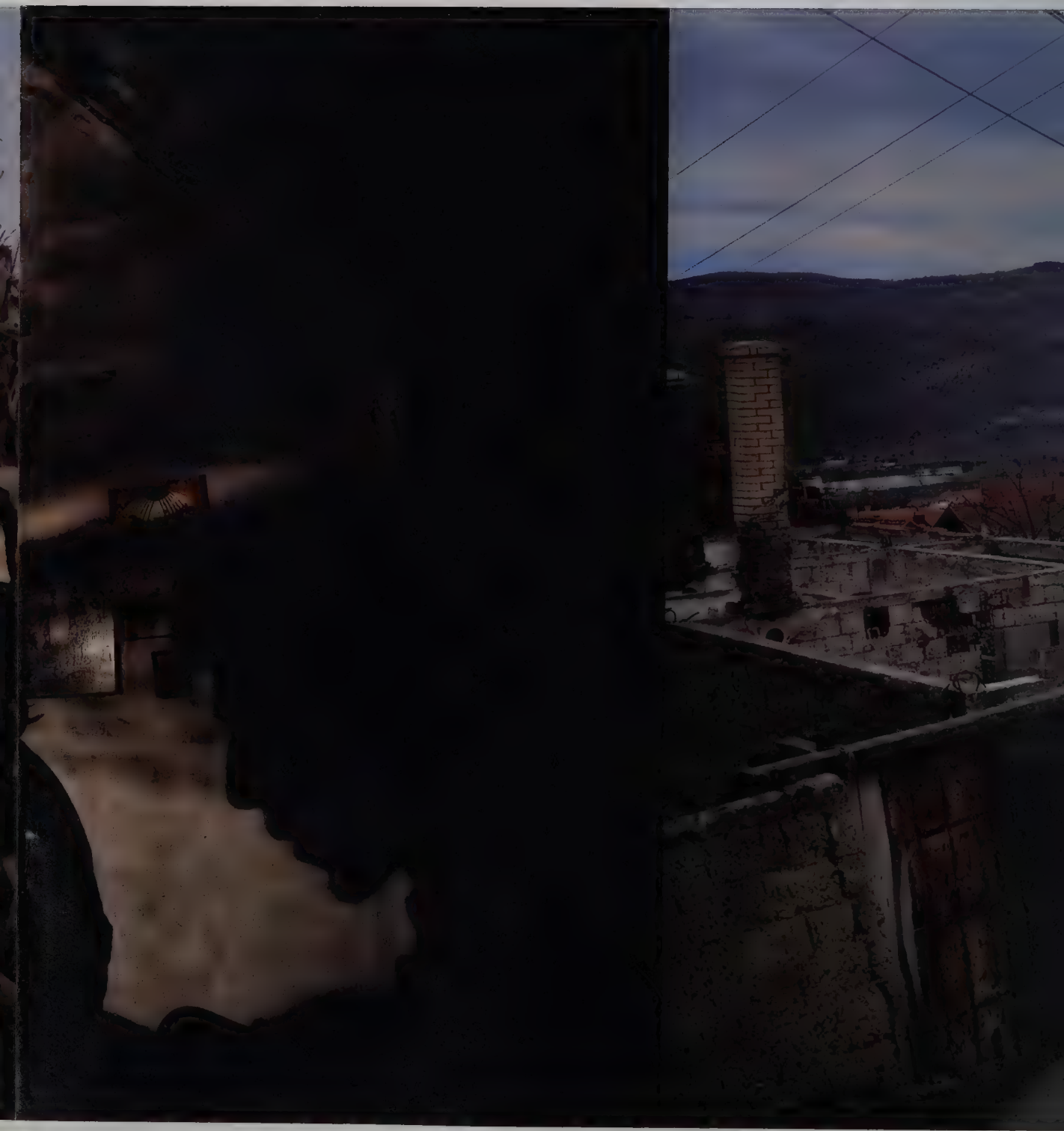






Harvest is often still brought in by hand in rural Serbia (left). Once the dominant republic in socialist Yugoslavia, Serbia retains an unbroken tradition of family farming because, unlike most communist lands, it largely escaped collectivization. Housing blocks sprout gray and tall in New Belgrade (above), a district of the capital built up after World War II to handle an increasingly urban population.







As dawn creeps over Velika Hoca in Kosovo, a young monk (left) recites the Serbian Orthodox liturgy in a chapel graced by fragments of medieval icons. Kosovo's Albanian majority declared independence from Serbia in 2008. Both nationalities argue the land is rightfully theirs. In ethnically split Mitrovica, French peacekeepers (above) fight boredom near homes ruined in interethnic conflict.



IN THE ISOLATED VILLAGE of Velika Hoca in southwestern Kosovo—a new nation or a rebellious province of Serbia, depending on whom you ask—people still talk about a brawl that broke out several years ago. It was after the Kosovo war, which had begun between separatist Albanian guerrillas and Serbian forces and had ended when NATO air strikes pounded Serbia and its strongman president, Slobodan Milosevic, into submission in June 1999. The West had stepped in to stop atrocities against Kosovo Albanians and avert a refugee crisis, assuming peace would reign once the dictator and his fighters were vanquished.

But the postwar reality fell short of peace. The majority Albanians were now on top, with the minority Serbs shoved to the bottom. Killings of civilians continued. And a new stream of refugees, Serbian this time, flowed from mountainous Kosovo, a region of endemic ethnic strife and economic stagnation smaller than metro Los Angeles.

On the day of the brawl in Velika Hoca, where a few hundred Serbs hunkered down in a valley between rocky hills, a local politician and former soldier named Bojan Nakalamic—stocky, swaggering, not yet 30 years old—struck a blow for Serbian pride. There's little enough of it left in this land Serbs call their ancient heartland.

As the story goes, several Albanian youths entered the village and began paying too much attention to some local girls. The day ended with the Albanians properly humbled and ejected from the Serbian redoubt, and it was Bojan Nakalamic who led the beating. To the people of Velika Hoca, it proved Serbs could still produce a champion, a man to fear. To me, each retelling made Nakalamic sound more like a nationalistic thug.

So it was a surprise when I finally met him to learn—in a classic, mind-bending Balkan reversal—that this tough guy who bashed Albanians for crossing cultural lines has sided with them politically, joining their new government

and defying Serbia's in the process. Supporting Albanian nationalism is not Nakalamic's aim. As a member of a beaten people in a hostile land, though, he has concluded that withdrawing inside a Serbian ghetto spells doom. He told me in careful English, "If we want to survive in Kosovo, we have to participate."

THE FLAG OF THE Serbian Orthodox Church, a guardian of Serbian singularity throughout centuries of struggle, carries the motto "Only Unity Will Save the Serbs." It flies over a people as deeply marked by the past as any can be. Wars and the whims of conquering empires have dispersed the Serbs, who number over ten million, southward to pockets in Kosovo (where 125,000 remain) and Montenegro; throughout central Serbia, where most live today; north to Hungary; and west across Bosnia and Herzegovina and Croatia. (Many others have dispersed to Western Europe and North America.) For centuries they have striven with epic fervor to unite their scattered people, define their lands, preserve their unique identity.

But unity is a quest that has brought the Serbs into harsh conflict with their neighbors in the Balkan ethnic patchwork and with the wider world. Today they are often viewed as the primary aggressors in the bloody wars of the 1990s that dismembered Yugoslavia. With many implicated in crimes against humanity—including ethnic cleansing and genocide in the war in Bosnia—Serbs heatedly protest that the West singles them out for special vilification while overlooking similar crimes perpetrated against them. They face a vexing question: What can Serbian unity mean in 21st-century Europe?

The question is as divisive for the Serbs as it is unsettling for their neighbors. To Nakalamic, the answer begins with taking care of his own village. So he has accepted a seat as the lone Serb on the Rahovec (Orahovac) municipal council, which oversees local villages, including Velika Hoca. The council answers to the Republic of Kosovo, the nine-tenths Albanian country that declared independence from Serbia in February 2008, with strong support from the United



Dragan Tanic (at right) is a Bosnian Serb. His wife, Sanja, is of mixed Muslim-Croat ancestry. They worry about raising a family in war-torn Bosnia and Herzegovina, where schoolchildren are divided into separate religion and history classes by ethnicity. "If we have children," Sanja asks, "where will they fit in?"

FOR CENTURIES SERBS have striven with epic fervor to unite their scattered people, define their lands, preserve their unique identity.

States and most of Europe. To many Serbs, that makes Nakalamic a traitor.

After Kosovo grabbed independence, TV viewers worldwide watched radical nationalists storm through Belgrade, Serbia's capital, smashing windows and torching a symbol of arrogant foreign meddling—the U.S. Embassy. The Serbian government views Kosovo's independence as an illegal dismemberment of Serbia's sovereign territory. It ordered Serbs in Kosovo—many of whom receive cash assistance from Serbia—to boycott elections there, and most obeyed. Without the requisite ballots from his district, Nakalamic lacks a council vote and thus can't fully participate in drafting budgets or ordinances.

Yet many Serbs seem resigned to the new borders, and to the prospect of a smaller, tamer Serbia at ease with its neighbors. "People are marching and demonstrating, but no one really believes we will get Kosovo back," said Marina Alavanja, a young woman I met in Belgrade as she and her fiancé, a Caribbean American from New York, had a midnight drink with friends on a stylish Belgrade street. Alavanja, a student in Florence, is the kind of liberal, internationally oriented Serb on whom Western governments pin their hopes. After Kosovo independence and the resulting riots, Serbian voters, in the spring of 2008, surprised the world by propelling into power a pro-European Union government that vowed to track down Serbian war criminals—evidence of a widespread belief that the country's best hope for cultural and economic growth is with the West.

But outsiders should never mistake resignation for acceptance, says Alavanja. "It's Serbian pride," she says. "We can't say, 'Sure, take Kosovo. Do whatever you want to us.' What kind of people would we be?" Srdja Popovic, a human rights lawyer who pursues accused Serbian war criminals, says the gulf between unreconstructed nationalists and Western-style Democrats, including Serbia's president, Boris Tadic,

is not as wide as outsiders may think. To Popovic, all major parties to some extent cling to the ideal of uniting Serbian-inhabited lands—a catalyst for war in the 1990s. "It's charitable to say this country is divided between democrats and nationalists," he says. "In reality, the nationalist ideal rules."

So does an obsession with the past, which for Serbs is a narrative of national suffering and valor. "Small peoples are often the victims of injustice," reflects Dragoljub Micunovic, an opposition figure during the Milosevic years and now a high-ranking Democrat. Micunovic cites the 1908 annexation of Bosnia (home to many Serbs) by Austria-Hungary. Though outraged, Serbia was forced to accede. But in 1914 Bosnian Serb Gavrilo Princip struck back, assassinating the Austrian crown prince in Sarajevo and sparking World War I. Half of Serbia's military-age male population may have died in the war, but the offending empire was obliterated, and in today's Serbia, Princip is a hero.

Ground zero for Serbian martyrdom is now Kosovo. To right-wing Serbs, politicians like the Democrats who decline to battle for it tooth and nail are Judases. The slur's religious imagery is intentional, for many Serbs regard Kosovo as their spiritual heartland. Slobodan Milosevic exploited this sentiment in the 1980s. He rose to the presidency partly on the platform of crushing Albanian power in Kosovo and died in 2006, during his marathon trial for war crimes that included violence against Kosovo Albanian civilians. It is difficult to judge whether the lingering aura of his propaganda offensive or authentic cultural veneration is what moves some Serbs to call Kosovo their Jerusalem, and some their Golgotha.

ON THE HILL west of Velika Hoca, below an observation post manned for nearly a decade by NATO peacekeepers, is a graveyard with a panoramic view: Along with clusters of old houses and hillside vineyards that supply the town's winery, owned by the Serbian Orthodox monastery, more than a dozen tiny churches pepper the valley. Some are medieval treasures adorned

Chris Carroll is a staff writer for National Geographic. Christopher Anderson's book about Venezuela, Capitolio, will be out this month.



with ancient frescoes of the life of Christ, icons of saints, the Last Judgment. No one, including the local priest, can explain why this unassuming agricultural place came over the centuries to be invested with such a weight of the sacred.

Some of the village churches, Bojan Nakalamic says, were built during the reign of King Stefan Dusan in the 14th century. The greatest ruler the Serbs ever had, he built a Serbian empire larger than any before or since. Kosovo was at its center when Dusan dubbed himself "Emperor and Autocrat of the Serbs and Greeks, the Bulgarians and the Albanians."

Chuckling, but with his hand on his heart, Nakalamic says: "Outside, I'm a small Kosovo politician. But inside, I'm Dusan."

Only a few decades after Dusan's death, in 1389, an army of perhaps 25,000 Serbs met a superior Ottoman force on Kosovo Field and went down in what many Serbs regard as glorious defeat. Serbia withered in the face of the expanding Ottoman Empire, which erased the country from the map within little more than a century. But the Battle of Kosovo lived on in Serbian literature and song as a symbol of the struggle against foreign domination.

Serbia regained independence in the 19th century and retook Kosovo in the 20th, during the collapse of the Ottoman Empire. Yet several centuries of Turkish domination had not only shaped the Serbs' sense of persecution, but also scattered them across the western Balkans. At

A crowded Belgrade trolleybus glides past the shattered Yugoslav Army Headquarters, hit by NATO air strikes during the 1999 Kosovo war. Though polls show strong support for joining the European Union, everyday sights like this prompt many Serbs to question their country's recent tilt westward.





Crosstown rivalry flares toward riot during a contest between Belgrade soccer foes Partizan and Red Star. Police mass outside. Serbia's restive young are called a lost generation—their options severely constrained in a country politically and economically isolated since the 1990s.





IMPLICATED IN CRIMES against humanity, Serbs protest that the West singles them out for vilification, overlooking similar crimes perpetrated against them.

the close of the 20th century, the tides of history turned again with the collapse of Yugoslavia. Many of the descendants of those who had fled Ottoman rule came surging back, adding a new chapter to the story of Serbian suffering.

THE SUFFERING INFLICTED by Serbs, however, is what the world remembers most vividly. In the old Turkish market section of the Bosnian capital, Sarajevo, a man named Dragan Tanic grabbed my arm and spun me toward the hills looming to the south. “If you stood here for ten seconds on the wrong day during the war—*poof*.” He tapped me in the middle of the chest to indicate I had just been killed by a sniper. “The Serb on the mountain kills you. Normal day in Sarajevo.”

The slight twist, which those familiar with Slavic given names might have guessed, is that Tanic is himself a Serb. Like several thousand other Bosnian Serbs around Sarajevo, Tanic took up arms against the Serb forces that laid siege to the city soon after Bosnia declared independence from Yugoslavia in 1992. Under the circumstances, religious heritage mattered less than who was shooting at him. “They were attacking my home, and if someone attacks my home, I defend it.”

But he was in the minority. Other Bosnian Serbs—unwilling to live in a country where Bosnian Muslims, or Bosniaks, would dominate—elected to fight Bosnian independence. They controlled the arsenal of the Yugoslav People’s Army and overran 70 percent of Bosnia in the first months of the war, forcing non-Serbian populations out of the land they conquered. The order of the day was to clean the territory of large, troublesome minority populations unsuitable for inclusion in a unified Serbia.

Late in the war, ethnic cleansing would lapse into simple slaughter around the eastern Bosnian town of Srebrenica. There Bosnian Serb forces killed perhaps 7,000 mostly civilian Bosniak men and boys—lining some up and shooting them, hunting others down as they tried to escape. It was the bloodiest single episode in Europe since the close of World War II—the first instance of genocide in Europe

since the Holocaust, the International Court of Justice ruled.

Srebrenica was a defining event in the modern history of the Serbs. Although the court later ruled that Serbia itself was not directly implicated, the Bosnian Serbs who carried it out had helped cast all Serbs as bloodthirsty killers—damaging national interests, perhaps, more than any of their enemies could.

When the war ended in 1995, and the four-year siege of Sarajevo soon after that, Bosnia was left more or less cleanly divided between ethnic groups. Today, though most people get along in a fashion, ethnic leaders continually squabble. Bosniak politicians inveigh against Serb separatism and war criminals who still run free, while leaders of the Serbs—37 percent of Bosnia’s population—tweak Bosniaks with rhetoric about secession. In the capital, most Serbs have decamped for Serb-controlled parts of Bosnia, while Bosniaks have flowed in the opposite direction. Sarajevo retains a patina of multiethnicity—Tanic and his Muslim-Croat wife, Sanja, are an example. But in reality, today it is a mostly homogeneous Muslim city, unlike the one Dragan Tanic remembers from childhood.

At a café on lively Ferhadija Street, just steps from places where scores of civilians were eviscerated by Serb shelling during the war, Tanic said: “I grew up just around the corner, where my mother still lives. But I can sit here for two hours and see no one I know.”

HIGH ABOVE THE confluence of the Danube and Sava Rivers in Belgrade, the massive Kalemegdan Fortress guards a hill where Roman soldiers camped. Later, foreign empires that ruled this land used the castle as a border outpost. Below are the shabby-elegant streets of Belgrade’s Old City—sprinkled with buildings still in ruins from attacks by NATO warplanes during the Kosovo war a decade ago. To the west across the Sava is New Belgrade, a faceless, sprawling urban grid thrown up after World War II. And on the city’s outskirts is a leafy, peaceful little camp—a former communist youth center—that houses

Serb refugees who fled the new countries born during Yugoslavia's disintegration.

One is Maritsa Stula, a small, serene woman in her mid-50s with a distant smile. Her home was Osijek, a Croatian city a hundred miles northwest of Belgrade, in a region where, centuries ago, Austrian rulers gave land and religious freedom to Serbs fleeing Ottoman rule if they agreed to guard the military boundary against the Turks. By the 1970s, when Stula began building a family in Osijek, both empires were long extinct, but more than 600,000 Orthodox Serbs lived in Roman Catholic Croatia—making up some 14 percent of the population.

In those days, Stula says, no one cared who was a Croat and who was a Serb. Yugoslavia was strong and prosperous, President-for-life Marshal Tito still held power in his able hands, and all Yugoslavs were equal.

So she found it incomprehensible that her neighbors should listen when, in the waning days of Tito's rule, the trumpets of nationalism began blowing in Belgrade and the Croatian capital, Zagreb. Serbs spoke of how Nazi-allied Croats had confined them in death camps and slaughtered them in the hundreds of thousands 50 years before. Were new massacres in the offing, they wondered? Croats told of persecution in Yugoslavia by Serbian communists, who now plotted to appropriate thousands of square miles in the heart of Croatia for Greater Serbia. The power of nationalist politicians across tottering Yugoslavia grew, and life in Osijek soured. In 1990 Serbs elsewhere in Croatia declared independence, driving Croats from their homes across nearly one-third of the republic. Then in June 1991, Croatia voted to secede from Yugoslavia.

One day the following month, an anguished Croat neighbor appeared at Stula's door; hard men had ordered him to shoot her family if they didn't leave at once. These were not the good people of Osijek, but angry country people—perhaps they'd lost their own homes, Stula says. She boarded an eastbound bus with her three children, her husband followed, and she has not seen her home since.

Stula was part of a first wave; hundreds of

thousands more fled at the end of the Croatian war for independence, when Croatian forces overran the breakaway Serb regions with logistical and air support from NATO countries. Hundreds who stayed behind, mostly the elderly, were murdered in the aftermath.

As of 2008, Serbia harbored almost 320,000 people uprooted from the far corners of the former Yugoslavia. About 200,000 came from Kosovo, where Milosevic's response to NATO bombing had been a bizarre scheme to empty large sections of the province of Albanians. When Milosevic folded and more than 850,000 Albanian exiles streamed back from foreign refugee camps, many Serbs fled, knowing they were ripe targets. More were driven out later, despite the presence of international peacekeepers, who sometimes failed to respond as angry mobs attacked unarmed civilians.

The rest came from Croatia, like Stula, or Bosnia. Stula speaks longingly of her lost Croatian home, but she says things could be worse. She found a job as a cook in a restaurant at Delta City, a new luxury mall opened in 2007 by Serbia's richest man. Thanks to the economic reforms of post-Milosevic governments, Serbia's economy has rebounded strongly, with growth in recent years averaging 7 percent. Personal incomes are rising quickly, and the mall is busy every day. It's certainly the best paying job Stula has ever had. But if she can save the money to get European Union travel papers, she plans to leave Serbia for good—maybe go to England, where her oldest son has managed to enroll as a college student.

Stula had patted my arm consolingly when she learned my nationality, as if sorry to be the one to break the news. "America. *Ne dobra. Ne dobra*," she said. Not good, not good. Why, she asked, does America kick poor people out of their homes in Kosovo? "Bill Clinton, *ne dobra*. Albright, Rice, *ne dobra*. Bush..."

At a small party one night on a houseboat on the Sava River in Belgrade, the upbraiding was less gentle, the sense of grievance far more raw. Two young men with long hair and red faces invited to me to guess how many tons of

Inside a shipping container used as a house, television briefly distracts Radovan Peric and young neighbor Djordje Jovanic from their grim lives as displaced persons. After the 1999 war in Kosovo, some 164,000 Serbs fled. Ethnic violence forced others into camps like this one near Prishtina, Kosovo's capital.







A Muslim couple strolls past a Sarajevo cemetery dedicated to Bosnian Army war dead. From 1992 to 1996, rebel Bosnian Serb forces occupied hills ringing the city and poured down shells and sniper fire, killing thousands in an attempt to carve out a Serbian state in multiethnic Bosnia.



depleted uranium munitions the U.S. dropped on their country in 1999 and how many cancer cases could result. Did I know about the Serbian civilians killed by U.S. bombing in the Kosovo war? one asked. Not likely, they guessed, as the U.S. media effectively censor material in which Serbs don't appear as latter-day Nazis. They ranged further back, reviewing the tragedies of both World Wars. One of the two—an English speaker who looked like a twentysomething urbanite from anywhere in Europe—seemed on the verge of tears. Did I in fact have any idea of all the things Serbs have suffered?

THERE IS A VILLAGE in western Serbia called Sljivovica, Serbian for the plum brandy known as slivovitz in English-speaking countries. It's one of a spectrum of fruit-based spirits called *rakija*, central to the social life of Serbs and other Yugoslavs, a drink with which to toast friends and greet visitors. As a village priest in Kosovo said one morning after his wife poured a tiny glass of clear liquid probably well north of 100 proof, good *rakija* is a fire in the belly, not the throat. With watering eyes, I tried to give the impression all the pain was in my stomach.

But with Serbia edging toward EU membership and in the midst of harmonizing its laws with European standards, can true Serbian *rakija* survive? Liquor production is tightly regulated in the EU, favoring large distilling companies, while the most prized *rakija* is homemade, like the priest's.

Sljivovica seemed an apt place to find the kind of domestic *rakija* makers who might fear joining Europe. Men having coffee at a *kafana* near the highway pointed to a narrow lane running up a nearby hill.

Beside the last house on the road, two men, one young and one old, worked at a blackened pot still that belched smoke and a sweet-sour barnyard odor. Eighty-year-old Ostoja Stanic fed the firebox, while Milan Stanic, 32, poured buckets of fermented plums into a pan. Half an hour later, the mixture began to boil, and a thin stream of alcohol flowed out. Sweet and weak, it is called soft *rakija*. A second distillation

would bring it up to strength. I asked Milan Stanic whether EU bureaucracy could shut down this little still.

He broke into English to emphasize his point: "We want EU."

He showed off some new oak barrels—each holds thousands of liters—near a half-finished concrete building. The Stanic family was about to expand its operation, he said. A larger still was on order. Milan had been consulting agricultural experts about the family's plum crop and researching distillation on the Internet. He indicated an imaginary bottle hovering in front of him, tracing the lines on its label with his finger—"Sljivovica from Sljivovica." As the country grows closer to the rest of Europe, he said, new markets will open, and people who could find only industrialized slivovitz will soon be able to try the real thing. In the cellar of the house, Milan sucked on a plastic tube and siphoned aged *rakija* into a two-liter bottle. He winked, "I had to learn this during the NATO bombing; it was the only way to get gasoline." The topic is never far from the surface. Then he shook my hand and hurried off to the wedding of an employee of the family's *kafana*.

Ostoja Stanic stayed behind to mind the still. He spoke of the war of his own youth and the confusing, fratricidal exploits of two rival bands of anti-Nazi resistance fighters: Chetniks, loyal to the Serbian monarchy, and communist fighters led by Tito, Yugoslavia's eventual leader. The Chetniks used to cut people's throats around here, he said. To the teenaged Ostoja, the real heroes were Tito's Partisans, who made a heroic, doomed stand against the Germans in the nearby city of Uzice. But I knew that within a few hours' drive were other old men who could tell how Tito's fighters slaughtered the innocent there. It was a perfect slice of Serbian history—soaked in blood and bravery, with few happy endings or undisputed truths.

But Ostoja Stanic had only been making idle conversation. His real business is making *rakija*. He handed me the two-liter bottle of slivovitz, patted me on the back when I tried to pay, and went to load firewood into the smoking still. □



A family in southern Serbia rolls past a sign urging, "*Srećan put!*—Have a nice trip!" It could be a farewell wish for their Zastava car. Production ended last fall when Italian carmaker Fiat bought the plant—a step widely seen as a reward from the European Union after Serbia elected a pro-Western government. As the factory is retooled, Serbia's people swing between bitterness over recent hardships and hope for a better future in a nation peacefully integrated into Europe.



COSMIC

The twin-mirrored Large Binocular Telescope in Arizona will deliver images ten times sharper than the Hubble Space Telescope's.



A NEW GENERATION OF GIANT
TELESCOPES WILL CARRY THE EYE
TO THE EDGE OF THE UNIVERSE

VISION



WINDOW ON THE UNIVERSE Spread across 128 monitors at NASA's Advanced Supercomputing facility in California, colorized red and green nebulae span a vast region of our galaxy. Called hyperwall-2, the system helps researchers visualize huge amounts of data from the latest telescopes.



WHEN YOU START STARGAZING WITH A TELESCOPE, two experiences typically ensue. First, you are astonished by the view—Saturn's golden rings, star clusters glittering like jewelry on black velvet, galaxies aglow with gentle starlight older than the human species—and by the realization that we and our world are part of this gigantic system. Second, you soon want a bigger telescope.

Galileo, who first trained a telescope on the night sky 400 years ago this fall, pioneered this two-step program. First, he marveled at what he could see. Galileo's telescope revealed so many previously invisible stars that when he tried to map all of them in just one constellation, Orion, he gave up, confessing that he was "overwhelmed by the vast quantity of stars." He saw mountains on the moon—in contradiction to the prevailing orthodoxy, which declared that all celestial objects were made of an unearthly "ether." He charted four bright satellites as they bustled around Jupiter like planets in a miniature solar system, something that critics of the Copernican sun-centered cosmology had dismissed as physically impossible. Evidently the Earth was a small part of a big universe, not a big part of a small one.

And soon, sure enough, Galileo went to work making bigger and better telescopes. Large light-gathering lenses were not yet available, so he concentrated on making longer telescopes, which produced higher magnifying powers and reduced the halos of spurious colors that afflicted glass lenses in those days. Subsequent observers took the design of glass-lensed, refracting telescopes to great lengths, sometimes literally so. In Danzig, Johannes Hevelius deployed a telescope 150 feet long; hung by ropes from a pole, it undulated in the slightest breeze. In the Netherlands, the Huygens brothers unveiled lanky telescopes that had no tubes at all: The objective lens was perched on a high platform in a field, while an observer up to 200 feet away aligned a magnifying eyepiece and peered

through it. Such instruments proffered fleeting glimpses of planets and stars that, like the dance of the seven veils, only aroused a burning desire to see more.

The reflecting telescope, pioneered by Isaac Newton, made it practical to gratify such desires: Mirrors required that only one surface be ground to gather and reflect starlight to a focal point, and since the mirror was supported from behind, it could be quite large without sagging under its own weight, as large lenses tended to do. William Herschel discovered the planet Uranus with a handmade reflecting telescope—he cast his metal mirrors in his garden and basement, and once had to flee from a coursing river of molten metal after the horse-dung mold fractured. Spiral-armed galaxies were first glimpsed through a massive reflecting telescope, with a six-foot diameter primary mirror, that Lord Rosse constructed on his estate in Ireland.

Today's largest telescopes have mirrors up to some ten meters (33 feet) in diameter, with quadruple the light-gathering power of the legendary five-meter Hale Telescope at Palomar Observatory in southern California. Looming large as office buildings, some of these giants are so highly automated that they can dust off their optics at sundown, open the dome, sequence and carry out observations throughout the night, and shut down come threatening weather, all with little or no human intervention. Yet humans, being human, still intervene a lot, if only to make sure nothing goes awry: To lose just one night's work at a big telescope these days is to squander as much as \$100,000 in operating costs.



BEGINNINGS Four hundred years ago Galileo gave birth to modern astronomy with the humblest of instruments, now preserved at a history of science museum in Florence, Italy. A one-and-a-half-inch lens displayed in an ornate frame (left, at bottom) was ground in 1609. Others followed. Fitted into simple wooden tubes just a few feet long, Galileo's lenses magnified the heavens, bringing Earth's moon, sunspots, and nearby planets into focus.

Three of today's largest telescopes—Gemini North, Subaru, and Keck—stand within hailing distance of one another atop the nearly 14,000-foot peak of Hawaii's Mauna Kea, an inactive volcano. The altitude puts them above 40 percent of Earth's atmosphere—and most of its water vapor, which is opaque to the infrared wavelengths the astronomers like to study—but also makes it difficult for the astronomers and engineers who work there to breathe and think. Many wear clear-plastic oxygen tubes in their nostrils as routinely as we might wear eyeglasses. Others rely on the body's ability to adapt but worry about making what they call a CLM, or "career-limiting mistake." "At altitude, we don't improvise; that would be a disaster," says Gemini astronomer Scott Fisher. "We're kind of trained monkeys up here. The real thinking goes on at sea level."

These big Mauna Kea observatories are comparably smart and costly, yet each exudes a distinct personality. The 8.1-meter Gemini telescope is housed in an onion-shaped silver dome ringed by a set of shutters that, when closed

during the day, make the observatory look as ungainly as a fat man in an inner tube. But the shutters open at dusk to create an enormous set of windows, three stories tall and stretching nearly three-quarters of the way around the observatory, that let in the night air and happen to afford a panorama of the blue Pacific all the way to Maui and beyond. Gemini's four main digital detectors—cameras and spectrometers, heavy as cars and costing around five million dollars each—are attached to a carousel surrounding the telescope's focal point, where they can be rotated into place in minutes. Computers run the telescope by night, shuffling requested observations to make the most of every minute. "We're all about nighttime efficiency," says Fisher.

The Subaru telescope's instruments are housed in alcoves like jeroboams of champagne in a heavenly wine cellar. (The comparison is not entirely fanciful; one leading Japanese

Timothy Ferris has written eight books, and made three films, on astronomy. Joe McNally has specialized in science and technology for the Geographic.

astronomer propitiates the gods at the start of each Subaru observing run by pouring vintage sake on the ground outside the dome at the four points of the compass.) When a particular instrument is required, a robotic yellow trolley makes its way to the alcove, picks up the detector, ferries it to the bottom of the massive telescope, and locks it in place, attaching the data

A TELESCOPE DOESN'T JUST SHOW YOU WHAT'S OUT THERE; IT IMPRESSES UPON YOU HOW LITTLE YOU KNOW.

cables and the plumbing for the detector's refrigeration system. Subaru happens to be one of the few giant telescopes that anybody has ever actually looked through. For its inauguration in 1999, an eyepiece was attached so that Princess Sayako of Japan could have a look through the scope, and for several nights thereafter eager Subaru staffers did the same. "Everything you can see in the Hubble Space Telescope photos—the colors, the knots in the clouds—I could see with my own eyes, in stunning Technicolor," one recalled.

Keck consists of two identical telescopes. Both have ten-meter mirrors made of 36 segments; with its support structure, each segment weighs close to a thousand pounds, costs close to a million dollars, and would suffice to create a fine, university-grade telescope on its own. The telescopes' "tubes" are spindly steel skeletons that look as delicate as spiders' webs but are more precisely configured than a racing sloop's rigging. "We use the telescope's mission to motivate ourselves," one Keck astronomer told me. "If a little wire or something is found intruding into the optical path, we think, If the light has been traveling through space for 90 percent of the history of the universe, and it got this close

to the telescope, we'd better make sure it gets the rest of the way."

Few of the astronomers awarded time on the big telescopes actually go there to observe anymore. Most submit their requests electronically—on a recent night at Gemini, the scheduled projects ranged from "Primordial Solar System Masses" to "Magnetic Activity in Ultracool Dwarfs"—and the results are sent back to them. Geoff Marcy, a modern-day Prince Henry the Navigator whose team has discovered more than 150 planets orbiting stars other than our sun, gets more observing time than most at Keck but has not been there for years. Instead, his extrasolar planet team observes from a remote operating facility at UC Berkeley. During observ-

ing runs, Marcy reports, "we settle into a routine of working all night. We have all our books and other resources here at hand, plus enough normal life so our spouses don't forget us."

IN ADDITION TO their unprecedented light-gathering power, today's big telescopes benefit from their adaptive optics (AO) systems, which compensate for atmospheric turbulence. The turbulence is what makes stars glitter; telescopes magnify every twinkle. A typical AO system fires a laser beam into a thin layer of sodium atoms 56 miles high in the atmosphere, causing them to glow. By monitoring this artificial star, the system determines how the air is churning and adjusts the telescope's optics more than a thousand times each second to compensate. Gemini pays a pair of students ten dollars an hour to sit outside the dome all night, walkie-talkies in hand, ready to warn the astronomers to turn off the laser should an airplane approach. "It's incredible to see in practice," says Scott Fisher. "When the AO system is off, you see a nice, pretty star that looks a little fuzzy. Turn the AO on, and the star just goes *phonk!* and collapses to a tiny point."

Objects in the night sky are measured in



MIRROR WORKS Ten-pound glass chunks (above) are loaded into a honeycombed mold at the University of Arizona. Hollow chambers reduce mass and help produce a lightweight mirror that

adjusts more quickly to ambient temperature changes. As the glass melts, the mold (below) spins to create a concave surface that gathers distant light and refocuses it inside a telescope.



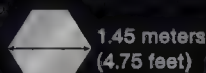


DETAIL MAN Beneath the University of Arizona football stadium, a technician pores over the surface of the 8.4-meter Large Synoptic Survey Telescope mirror, looking for major flaws. Over a period of months the glass will be polished to within one millionth of an inch of the precise concave shape required. A thin coating of aluminum will create the reflective surface.



BIGGEST OF THEM ALL

With a mirror four times wider than today's most powerful telescopes, the 42-meter European Extremely Large Telescope could be a hundred times as sensitive, thanks to the clarity gained by its adaptive optics system. It will explore the origins of the first stars and galaxies, search for Earthlike planets, and investigate the dark matter and dark energy that dominate the universe.



The primary mirror has 984 segments.

ALTITUDE CRADLE

DETAIL ABOVE

STELLAR LIGHT

INSTRUMENTS

LASERS

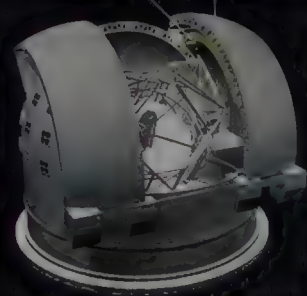
STATIONARY PLATFORMS on either side of the rotatable telescope hold instruments.

A TRACK can turn the 5,500-ton telescope system 360 degrees.

FIVE-MIRROR DESIGN

- 1 The 42-meter primary mirror** catches far-off light and reflects it to a smaller mirror centered above.
- 2 The 6-meter secondary mirror** bounces light back down to a still smaller mirror nestled in the primary mirror.
- 3 This third mirror** relays light to an "adaptive" mirror directly above.
- 4 The adaptive mirror** adjusts its shape a thousand times a second to correct distortions caused by atmospheric turbulence.
- 5 Another mirror** corrects blurring from wind hitting the telescope's dome and sends light to cameras and other instruments on the stationary platforms.

TWENTY-TON CRANE TWO SETS OF NESTED DOORS

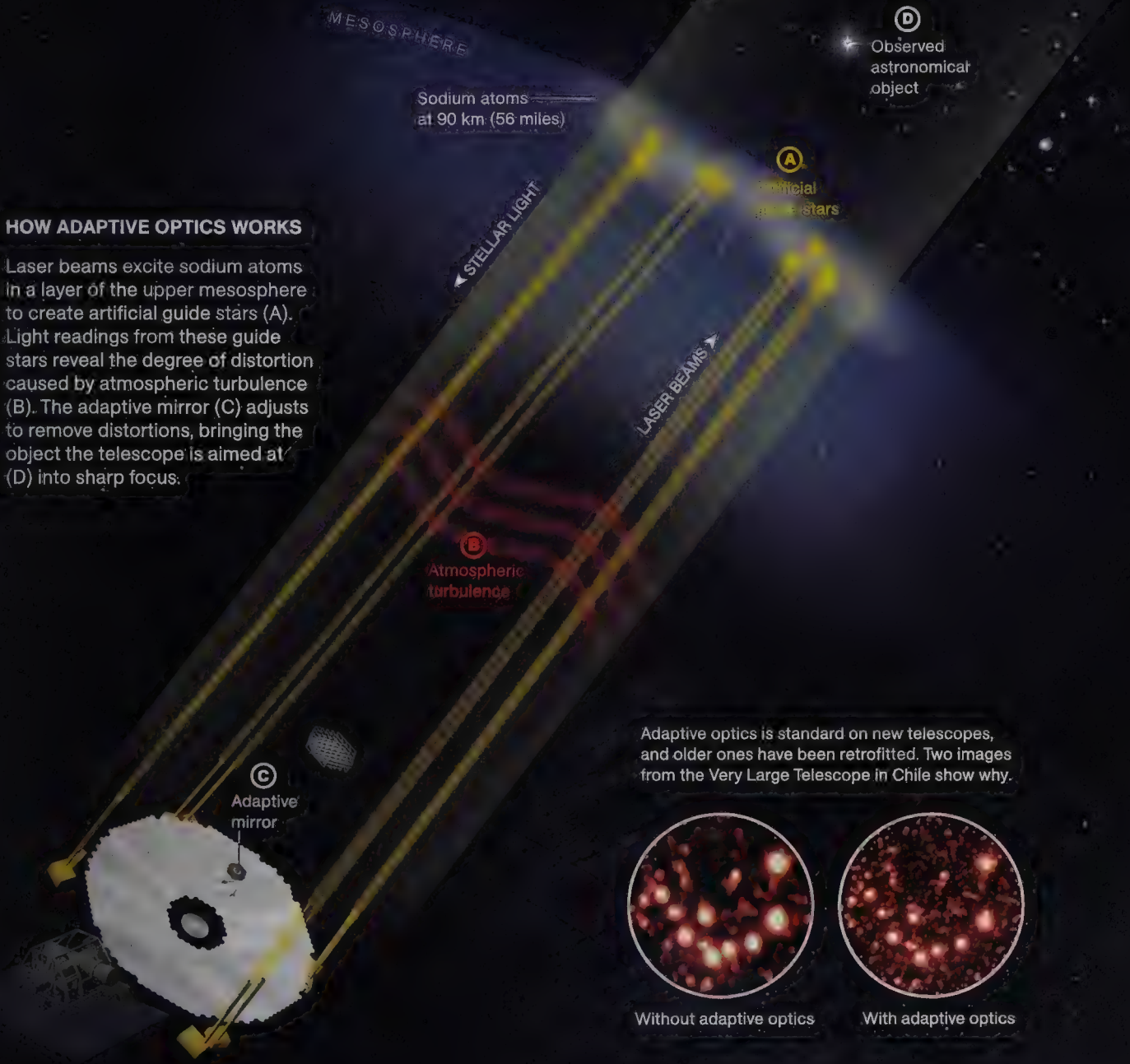


Height: 80 meters (262 feet)

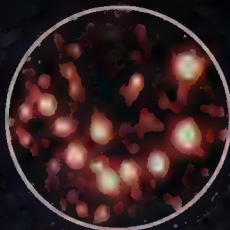
Diameter: 100 meters (328 feet)

HOW ADAPTIVE OPTICS WORKS

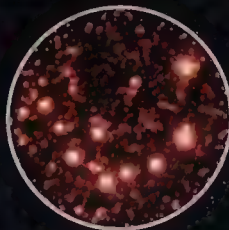
Laser beams excite sodium atoms in a layer of the upper mesosphere to create artificial guide stars (A). Light readings from these guide stars reveal the degree of distortion caused by atmospheric turbulence (B). The adaptive mirror (C) adjusts to remove distortions, bringing the object the telescope is aimed at (D) into sharp focus.



Adaptive optics is standard on new telescopes, and older ones have been retrofitted. Two images from the Very Large Telescope in Chile show why.



Without adaptive optics



With adaptive optics

UPCOMING TELESCOPES

● Size of today's largest mirrors (8-10 m / 26-33 ft)

Name	Large Synoptic Survey	Giant Magellan	Thirty Meter	European Extremely Large
Location	Cerro Pachón, Chile	Las Campanas, Chile	Chile or Hawaii	Argentina, Chile, or Canary Islands
Primary mirror diameter	8.4 m	Seven 8.4-m mirrors	30 m	42 m
Estimated completion	2016	2018	2018	2018

Dome covers not shown.

HIRAM HENRIQUEZ, NG STAFF; LINDSAY SERRA. ART BY DON FOLEY
SOURCE: EUROPEAN SOUTHERN OBSERVATORY (E-ELT DATA AND VLT IMAGES)

degrees, the full moon spanning about one half of a degree. Without AO, a powerful telescope on a fine night can perceive objects separated from each other by as little as one 3,600th of a degree, or one arc second. Thanks to Keck's AO system, UCLA astronomer Andrea Ghez was able to make a motion picture of seven bright stars whirling around the invisible black

ONE DAY, OBSERVATORIES SITTING IN CRATERS ON THE FAR SIDE OF THE MOON MAY PROBE THE UNIVERSE FROM IDEAL SURROUNDINGS.

hole at the center of our galaxy over a period of 14 years: The entire movie takes place *inside* a box measuring only one arc second on a side. Based on the frenzy of the stars in the grip of the black hole, Ghez calculated that it has a mass of four million suns, generating enough gravitational force to slingshot some stars that pass too close right out of our galaxy. Several such hypervelocity stars have been located, speeding off toward the depths of intergalactic space like party crashers ejected from an exclusive nightclub.

What's next? Even bigger telescopes, of course, with the capability to shoot cosmic pictures faster, wider, and in even greater detail. Among the behemoths due to come on line within a decade are the Giant Magellan Telescope, the Thirty Meter Telescope, and the 42-meter European Extremely Large Telescope—a scaled-down version of the 100-meter Overwhelmingly Large Telescope, which was tabled at the planning stage when its projected budget turned out to be overwhelming too.

Particularly innovative is the Large Synoptic Survey Telescope, or LSST, whose 8.4-meter primary mirror was cast last August in a spinning furnace under the stands of the University of

Arizona Wildcats' football stadium in Tucson. (The rotation technique produces a mirror blank that is already concave, reducing the amount of glass that must be ground away to bring the mirror to a proper figure.) Conventional telescopes have narrow fields of view, typically spanning no more than half a degree on a side—much too narrow to take in the enormous

patterns that grew out of the big bang. The LSST will have a field of view covering ten square degrees, the area of 50 full moons. From its site in the Chilean Andes, it will be able to image galaxies far across the universe in exposures of just 15 seconds each, capturing fleeting events to distances of over ten billion light-years, 70 percent of the way across the observable uni-

verse. "Since we'll have a big field of view, we can take a whole lot of short exposures and—*bang, bang, bang, bang*—cover the entire visible sky every several nights, and then repeat," says LSST Director Tony Tyson. "If you keep doing that for ten years, you have a movie—the first movie of the universe."

The LSST's fast, wide-angle imaging could help answer two of the biggest questions confronting astronomers today: the nature of dark matter and of dark energy. Dark matter makes its presence known by its gravitational attraction—it explains the rotation speed of galaxies—but it emits no light, and its constitution is unknown. Dark energy is the name given to the mysterious phenomenon that, for the past five billion years, has been accelerating the rate at which the universe expands. "It's a little bit scary," says Tyson, "as if you were flying an airplane and suddenly something unknown took over the controls."

The LSST could help solve these immense riddles thanks in part, oddly enough, to the science of acoustics. The big bang was *noisy*. Although sound cannot propagate through the vacuum of today's space—as pedants are fond of reminding the directors of science-fiction



WIDE RECEIVERS Massive trucks will drive 66 12- and 7-meter antennas into the Chilean desert to form a single huge radio telescope spanning miles (rendering below). The Atacama array will

collect data from within the clouds of dust and gas that gave rise to stars, planets, and galaxies. “It will enable us finally to penetrate cold, dark regions of the universe,” says project scientist Richard Hills.







SHARPER SIGHT The 5.1-meter Hale Telescope on Palomar Mountain, California, has done cutting-edge science for 60 years, making key discoveries about galaxies and quasars. An adaptive optics laser that shoots 56 miles up now lets Hale produce even sharper and more detailed views.

films—the early universe was a thick plasma and as alive with sound as a drummers convention. Certain tones resonated in the primordial plasma, like the tones of struck wine glasses, and these harmonies, etched into sheets of galaxies that today shamble across billions of light-years, contain precise information about the nature of dark matter and dark energy. If astronomers

WHAT'S NEXT? EVEN BIGGER TELESCOPES, WITH THE CAPABILITY TO SHOOT COSMIC PICTURES FASTER, IN EVEN GREATER DETAIL.

can map these large-scale structures accurately, they should be able to identify the signatures of dark matter and dark energy in the big bang's harmonics. The Sloan Digital Sky Survey, a pioneering wide-angle study, captured some of this information when it mapped the sky from 1999 through 2008. The LSST is designed to go much deeper into cosmic space. It may not resolve the mysteries, but, predicts Tyson, "it will go a long way toward showing what dark energy and dark matter aren't."

The LSST's photographic "speed" will also give astronomers a better look at events too short-lived to be readily studied today. Most astronomers, even amateurs using backyard telescopes and off-the-shelf digital cameras, regularly record fleeting events of unknown origin. You take a series of digital exposures, and in one of them a spot of light appears where none was before or after. It may have been a cosmic ray hitting the light-detection chip, a high-velocity asteroid hurtling through the field of view, or a blue flare on the surface of a dim red star. You just don't know, so you shrug and move on. Because the LSST will take so many repeat exposures of the entire sky, it could resolve many such riddles.

Tomorrow's enormous telescopes will do as much in one night as today's do in a year, but that will not necessarily render the older telescopes obsolete. When the giants come on line, says Scott Fisher, "the Geminis of today will become the telescopes that get to go out and do the surveys," finding interesting phenomena for the largest scopes to investigate in detail. "It's like a pyramid, and it feeds both ways: When a really big telescope finds something exciting that we can't spend every night observing, the astronomers can apply for time on a smaller telescope to, say, check it out every clear night for a year and see how it changes over time."

Orbiting space telescopes are opening up another dimension. NASA's Kepler satellite, which

launched in March 2009, is methodically imaging the constellation Cygnus, looking for the slight dimming of light caused when planets—some perhaps Earthlike—transit in front of their stars; Geoff Marcy's team will then use Keck to scrutinize stars flagged by Kepler to confirm that they have planets. In the future, pairs of mirrors deployed in orbit and linked by laser-ranging systems could attain the resolving power of telescopes measuring thousands of meters across. One day, observatories sitting in craters on the far side of the moon may probe the universe from surroundings ideally quiet, dark, and cold. The coming combination of smart satellites talking to big, increasingly automated ground telescopes, themselves linked together by fiber-optic networks and employing artificial intelligence systems to search out patterns in the torrents of data, suggests a process as much biological as mechanical, akin to the evolution of global eyes, optic nerves, and brains.

FILM DIRECTORS LIKE TO SAY that each movie is really two movies—the one you make, and the one you say you're going to make while raising the money. The point is that nobody can accurately predict the outcome of any genuinely

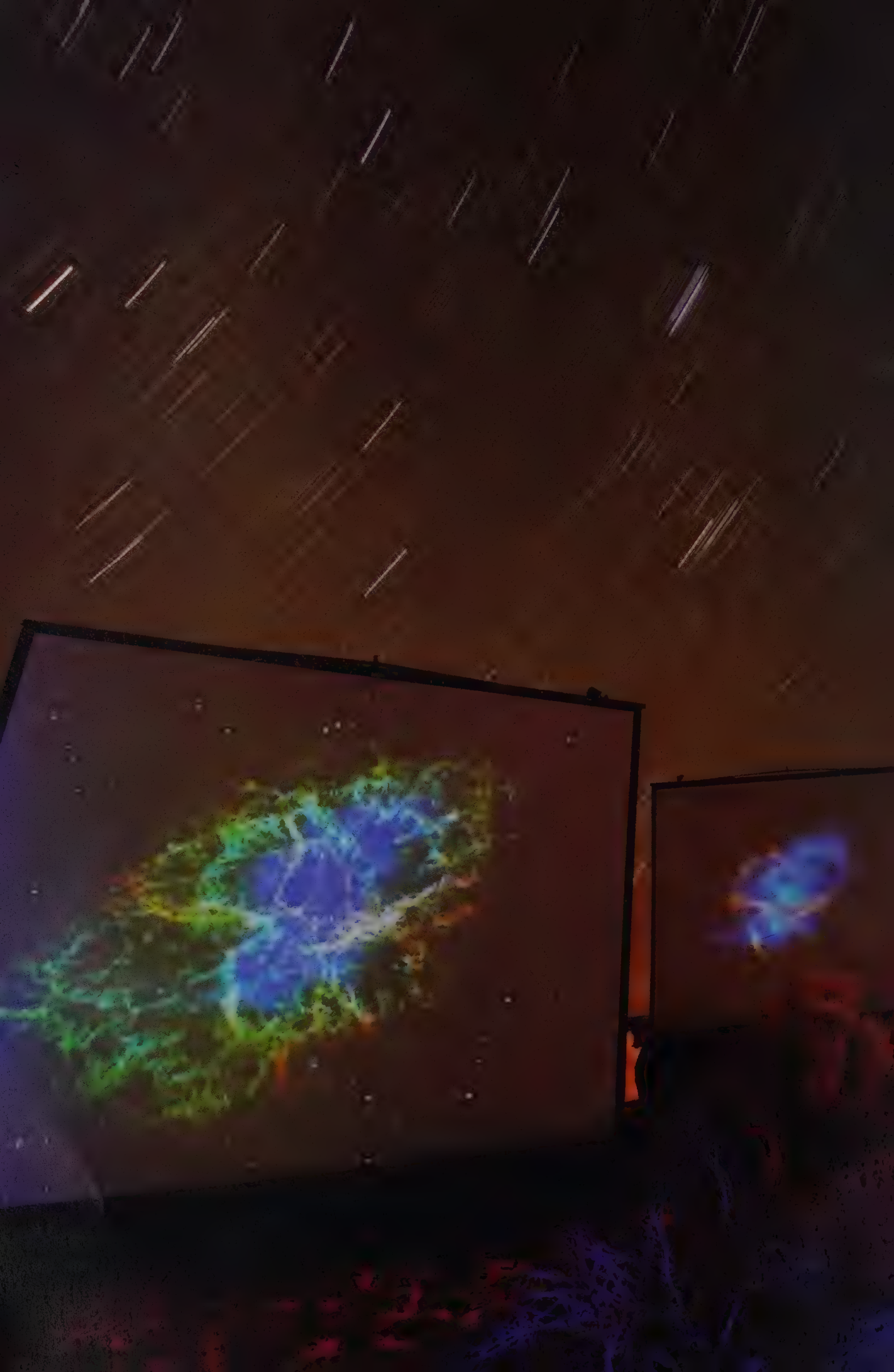


CLOUD FREE Crowded in prime territory, the Subaru, Keck I and II, and NASA Infrared telescopes (left to right) sit atop Hawaii's 13,796-foot Mauna Kea. Set above 40 percent of the atmosphere, they offer one of Earth's clearest views into space.

creative venture. The same is true of scientific discovery: Scientists can explain what they expect to accomplish with bigger and better telescopes, but such predictions are mostly just extrapolations from the past. "If you're going to Washington to seek funding for a new telescope and you make a list of what you'll see through this new window on the universe, you know that the most interesting thing it will discover is probably not on your list," says Tyson. "It's likely to be something totally new, some out-of-the-box physics that's going to blow our minds."

The marvelous model of the big-bang universe

pieced together in the 20th century arose largely from just such unanticipated discoveries. Edwin Hubble discovered the expansion of the universe accidentally, at the telescope: Cosmic expansion had been implied by Einstein's general theory of relativity, but Hubble knew nothing of the prediction, and not even Einstein had taken it seriously. Dark matter was discovered accidentally; so was dark energy. A telescope doesn't just show you what's out there; it impresses upon you how little you know, opening your imagination to wonders as big as all outdoors. "The spyglass is very truthful," said Galileo. □





TRIPLE VISION Portraits of the Crab Nebula captured in visible, infrared, and x-ray wavelengths (left to right) are projected on screens in Monument Valley, Utah, in a long exposure beneath a star-filled sky. Telescopes of the next decade will reveal our universe in ways never known before.



Clad in his signature red tie, socks, and sneakers, Garrison Keillor reports from a racetrack near Iowa's State Fair grandstand.

ON ASSIGNMENT **Carnival Connoisseur** Garrison Keillor's mellifluous voice is practically as American as apple pie. Since 1974 he's been telling stories from the fictional Minnesota town of Lake Wobegon every Saturday on his radio show, *A Prairie Home Companion*. This month Keillor chronicles the goings-on at a place that does exist, if only for a short time: the great American state fair. He hit several of these "ritual carnivals" last summer, but he remembers the day this photo was taken at the Iowa fair particularly well. It was shortly after his 66th birthday, and he'd just made a friend in the dressing room. "Senator Tom Harkin and his wife came and visited me there, and he ironed my shirt," he says. Keillor was busy shaving when the Iowa senator explained to him that as a child he had learned to "iron a good shirt." Keillor hosted a live performance of his radio show that evening and recalls the ideal setting: "An Iowa crowd on a warm summer night, who've eaten some ice cream and a pork chop on a stick—no better audience in the world. There isn't much you can do to put a dent in their day."



Robert Clark stands at the Victory Gate in Cambodia

ON ASSIGNMENT Angkor Man Ants feasted relentlessly upon Robert Clark as he photographed the ruins of the Khmer Empire city for this month's "Divining Angkor" feature. The bugs were distracting the day this picture was taken at the temple complex of Angkor Thom, but news from home diverted his attention. "It was the day Obama got elected," he says. When his wife called from Manhattan to give him the word, Clark pondered his locale. "I was at the Victory Gate. I thought that was fitting." For more on the empire, catch the National Geographic Channel's *Secrets of Angkor*, airing July 14 at 9 p.m.



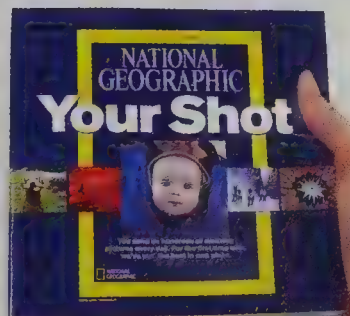
Geopuzzle Answers

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SPECIAL ISSUE Your Shot

Readers have submitted more than 100,000 photographs to *National Geographic's Your Shot* since that section's debut in March 2006. We usually have space to run just two of these images. This month we're publishing more than a hundred in our new collector's edition.

The special—with this cover (right)—is available June 30 for \$10.99 at newsstands, in bookstores, and on *ngm.com*. You can also order it online with a custom cover using your own downloaded photograph: *Your Shot* with your own shot.



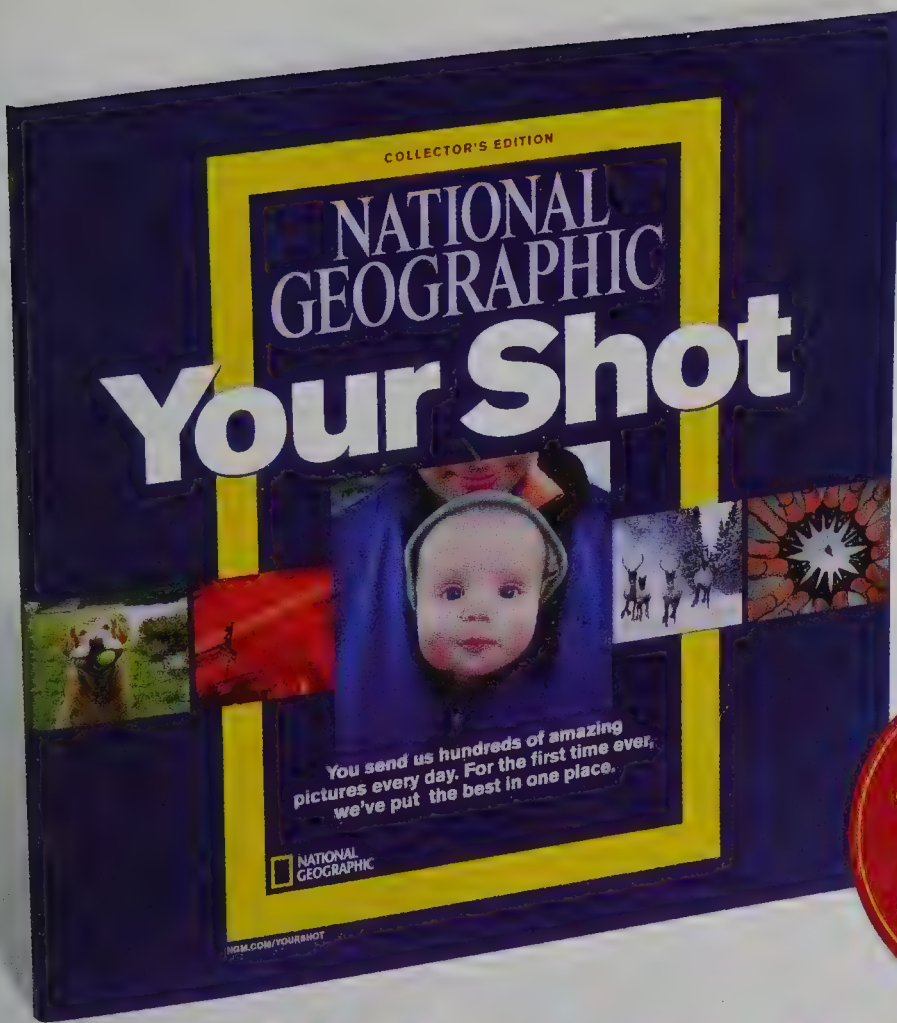


Searching for Home In 1918, New York photographer Lewis Hine—already known for his haunting portraits of Ellis Island immigrants and child laborers—arrived in Paris. He'd been hired by the American Red Cross to document its European relief efforts. In the waning months of World War I and after the armistice, Hine traveled through France, Belgium, and the Balkans shooting the shattered continent. He photographed this young Serbian refugee in the town of Grdjelitzza. Text accompanying additional Grdjelitzza photos by Hine notes: "With not even a roof over their heads, these families were finding their way back home on foot from northern Serbia where the Austrians and Germans had sent them to produce food for the enemy... When these people reach home, it will not be home, but simply ruins." —Margaret G. Zackowitz

🔗 **Flashback Archive** Find all the photos at ngm.com.

PHOTO: LEWIS W. HINE, NATIONAL GEOGRAPHIC STOCK

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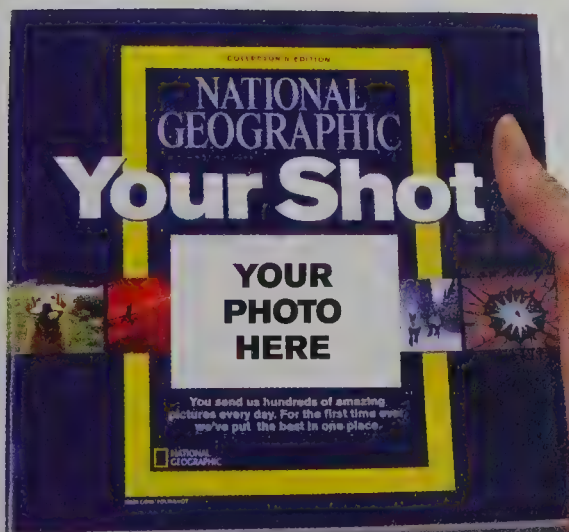
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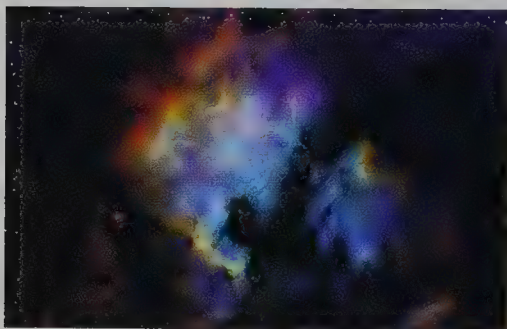
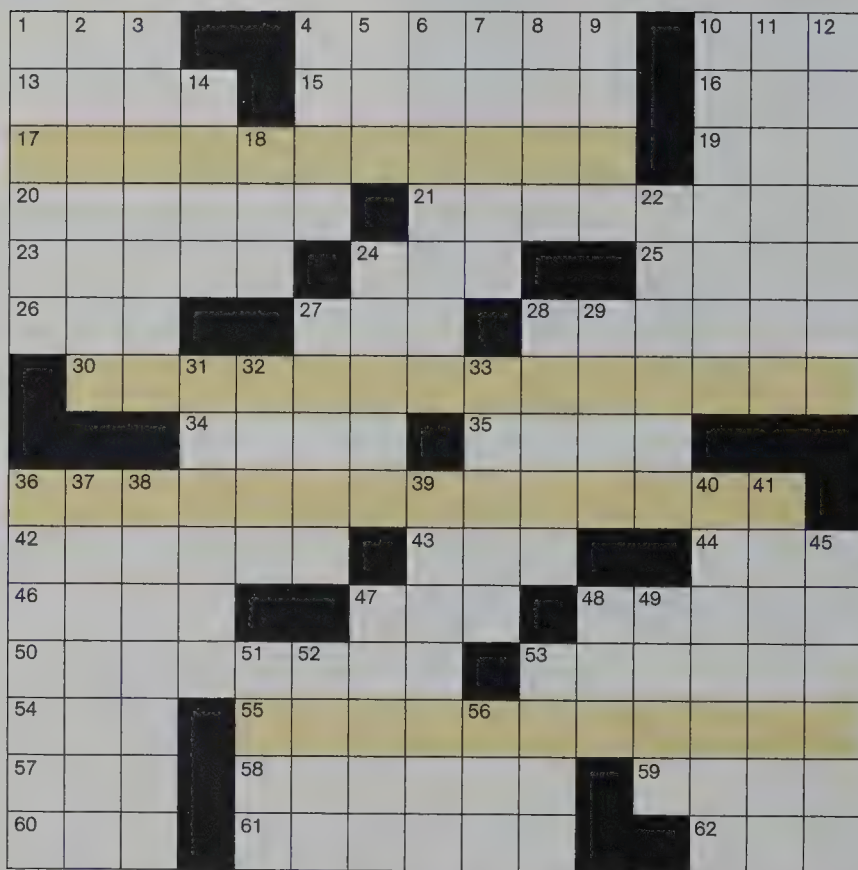
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GEOPUZZLE



Cosmic Hook

Puzzle by Cathy Allis

Word puzzles are as old as Pompeii and as new as the GeoPuzzle, which debuts this month. Tinted clues offer a punning tie to the telescope story on page 120. The nebula at left sits in the constellation named in the answer to 36 across.

ACROSS

- 1 Where bread is spit out?
- 4 How driftwood may be washed
- 10 Lamb pop
- 13 Kind of swimming kick
- 15 Gardener's need
- 16 Oklahoma city, site of the Chickasaw Nation headquarters
- 17 Function in the manner of a Mauna Kea telescope?
- 19 Boxing stats
- 20 Famed furrier's family
- 21 Whole numbers
- 23 Articles
- 24 My in Montreal or month in Madrid

- 25 China setting
- 26 Astronomers' meas. equal to 3,600 arc seconds: abbr.
- 27 Button on a sci. calculator
- 28 Doing mooing
- 30 Housing for a telescope in, say, the Andes?
- 34 On the briny
- 35 "Dedicated to the ___ Love"
- 36 Constellation the Kepler satellite will image from on high?
- 42 Kitchen gadget
- 43 Letters preceding an alias

- 44 "Hanoi Hilton" setting
- 46 Wan
- 47 Wino's withdrawal woe
- 48 Crooner Mel, "The Velvet Fog"
- 50 Means, e.g.
- 53 LummoX
- 54 Cornish or Devon ___ (cat breed)
- 55 Astronomers' tribute to improved optics?
- 57 Compass dir.
- 58 Bring into harmony
- 59 Fortune-teller
- 60 Drug Dr. Leary dropped
- 61 Social climber's goal
- 62 Letters on some ADA members' shingles

DOWN

- 1 In a panic
- 2 Reliable
- 3 ___ Bay, Jamaican city
- 4 Says "Who?"
- 5 Yonder ewe or yacht
- 6 Maximally corny
- 7 Tandoor, kiln, etc.
- 8 Prefix with angular
- 9 Screen star Sommer
- 10 Earns, big-time
- 11 Worshipful
- 12 Spa specialty
- 14 Latch (onto)
- 18 E-filing destination
- 22 Knighted nephew of King Arthur
- 24 Single-celled microorganism
- 27 ___ d'Alene, Idaho Panhandle city
- 28 Singer Lotte, Kurt Weill's wife
- 29 Neighbor of Wash.
- 31 Special-purpose envelope
- 32 Direction from which *el sol* rises
- 33 Joints in horse hind legs
- 36 Raiment
- 37 Adds yeast to
- 38 Messaged, an outdated way
- 39 Opts for a restaurant experience
- 40 Not in one's choir garment, e.g.
- 41 White reindeer-herding dog
- 45 The diameter of telescope Subaru's primary mirror is 8.2 of these
- 47 Nile's mouth formation
- 48 Chinese "way"
- 49 Nickname for a bygone classic American car
- 51 Sounds from successful solvers
- 52 Commerce treaty before NAFTA
- 53 Leaves
- 56 Serengeti antelope

Answers in
Inside Geographic

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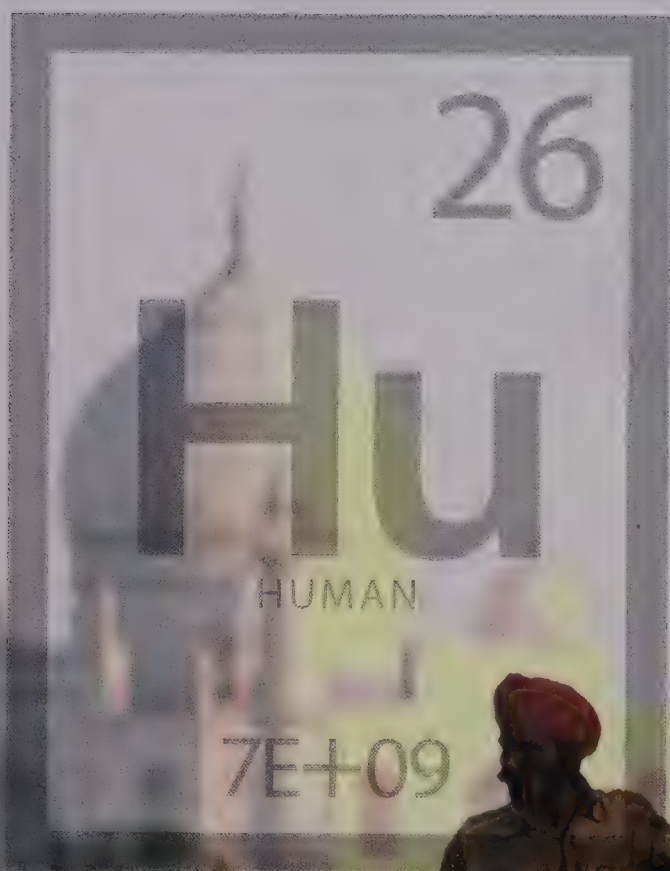
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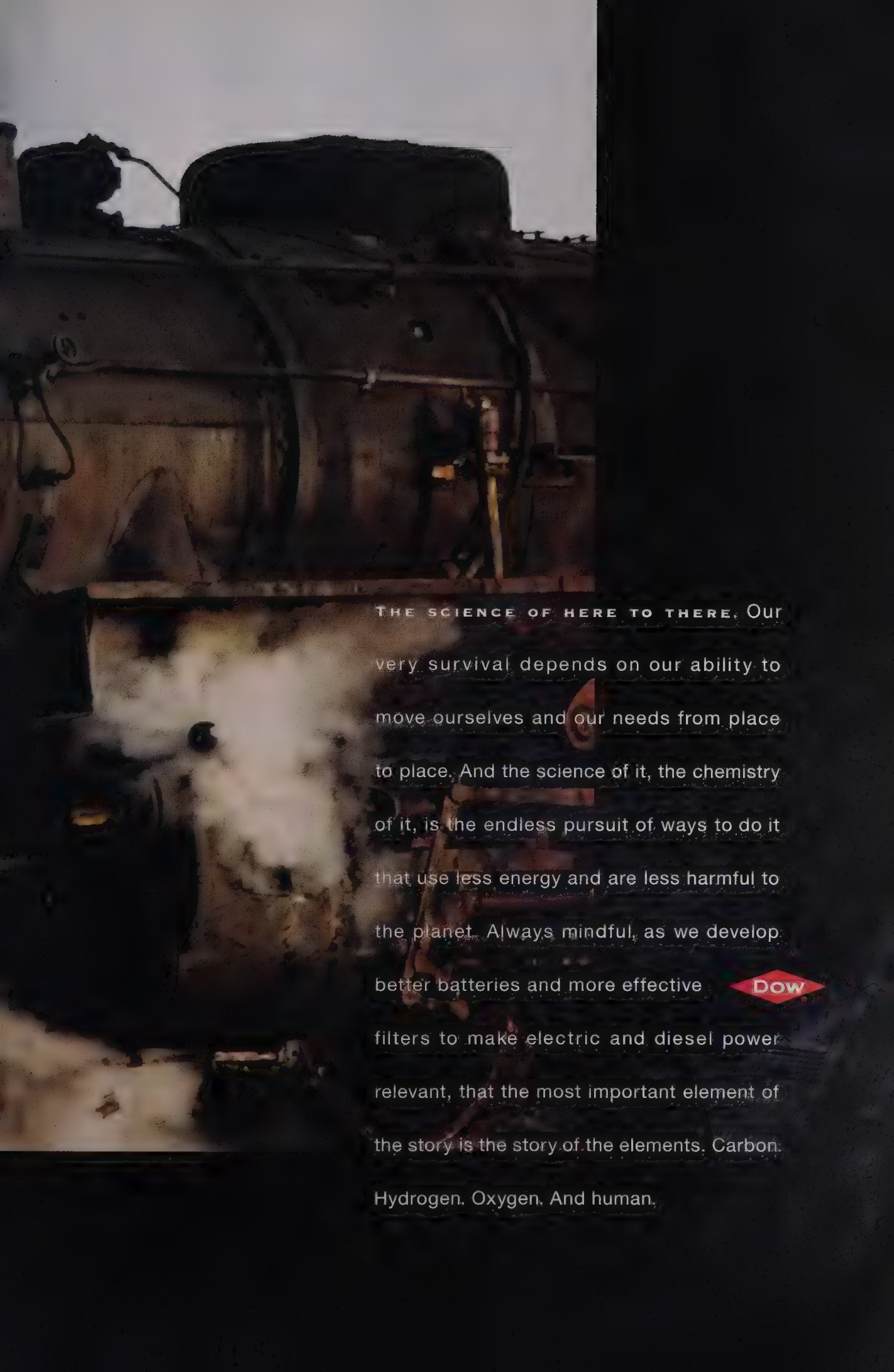
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Sockeye salmon shoot up the rapids and flip in midair. I see their mirror-bright sides catch and scatter the sun. Propelled by instinct, they return to their birthplace to spawn. Commercial fishermen caught 90 percent of these fish's mates even before the salmon began their odyssey up British Columbia's Fraser River. The ones left have beaten the odds so far. But their journey isn't over, as I found out many years ago on an early assignment for the *Geographic*. I watch as 13-year-old Gordon Alec (above), of the Lillooet tribe, dips his net in the rapids and pirouettes to his left with a captured fish. The ritual of netting salmon is Gordon's ancestral legacy. Drying racks line the Fraser's banks. Young and old camp out under the summer sky and celebrate the catch. But regret is expressed too, as elders recount how diminished the run has become in their lifetime.

This month, writer David Quammen and photographer Randy Olson take us to Russia's Kamchatka Peninsula. Salmon runs are still huge and healthy there. It's a rugged landscape, where at least 20 percent of all Pacific wild salmon go to spawn. "Salmon heaven," Quammen calls it. But this salmon heaven is threatened. It's the same story many fisheries face. The direction this narrative takes—whether someday Kamchatka's salmon runs will be spoken of with regret—will be determined by management decisions made in the next few decades. "At present," says Quammen, "the situation is fluid."

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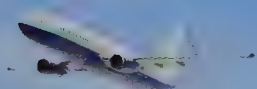
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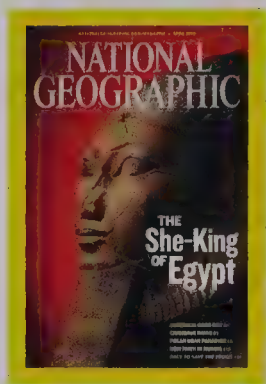
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April 2009

Australia's Dry Run

It is really buckling to hear about the situation of these broken Australian farmers wishing for a freak monsoon. It is outrageous also that the Australian officials are drying up their livelihoods and not really giving a hooting care. The planet we live on is precious. Humans have been too greedy for too long. The world is winking at us to change our ways. We cannot just go on patching it up willy-nilly.

BEN VAN HEYGEN
Cambridge, England

As an Australian, I enjoyed your article. However, to refer to Australia's drought as the most severe in "the country's 117 years of recorded history" does a disservice to the indigenous inhabitants of Australia. Their "recorded history" might not be ours, but their extraordinarily detailed oral history and traditions of personalizing the environment point to a history that is deeper and more complex than anything we can offer.

GEOFFREY D. BATROUNEY
New Rochelle, New York

Your story left me with the feeling it was written with only

an American audience in mind. It was full of words foreign to the Australian language. No one in Australia has a "ranch," they have "properties" or "stations." No one drives "pickup trucks," they drive "utes." They live in "homesteads," not "farmhouses," that are in the middle of "paddocks," not "meadows" or "fields." Mick Punturiero's fellow farmers would have a hard time saving "dimes" as we don't have any. It was a great article, but it should have been edited by an Australian.

KARYN ALEXANDER
Dubbo, New South Wales

Ice Paradise

I was a bit disappointed that the article and accompanying pictures left out one hardy animal: the 2,500 human beings on Svalbard. How do they live and survive in such a hostile (to humans) environment, particularly during the winter darkness?

FRED KAISER
Silver Spring, Maryland

The article by Bruce Barcott captured the essence of Svalbard beautifully. My only regret is that he did not mention a factor that will probably add even more problems. As the ice recedes and opens up sea routes, some of the world's most powerful governments and big businesses are clamoring over the rights to access the area's oil and mineral reserves. Regardless of the fact that much of Svalbard lies within national parks or nature reserves, the very real threat of heavy industry gaining a foothold under all manner of pretexts is a real danger. Whatever reassurances are given,

do we really want to risk more *Exxon Valdez* disasters and the associated catastrophic legacy?

FRIEDY LUTHER
Spofforth, England

The King Herself

I am a psychotherapist in private practice and specialize in working with transgender clients. I have done so for over two decades and have seen hundreds of people. Your story unfolds with all the little clues that reveal a tale of gender transition. Suppose for a moment that Hatshepsut was transgender. That would also easily explain the success of her rule. Emerging science is leading to the knowledge that brains of transsexual people look much more like their desired gender than their birth sex and that there is some complex set of factors that bring about this change prior to the birth of the child. This simply means that though her body was female, her brain was more male, and thus some of the more "male-attributed" things related to ruling a kingdom were more available to her. Since we will never truly know who Hatshepsut really was, why can't this explanation be among her/his possibilities? Food for thought, I hope.

MOONHAWK RIVER STONE
Niskayuna, New York

Corrections, Clarifications

April 2009: Soul of Russia
Page 114: The correct name of the priest performing the baptism is Father Alexander.

Email ngsforum@ngm.com
Write National Geographic Magazine, PO Box 98199, Washington, DC 20090-8199. Include name, address, and daytime telephone. Letters may be edited for clarity and length.

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LETTERS

The article on Hatshepsut's mummy, however focused on her strengths as a ruler, also made several mentions that she was fat. Maybe that is why she portrayed herself as a man—she was trying to encourage her subjects to look beyond her physicality and judge her for her accomplishments.

LISA WEBB
Green Brook, New Jersey

Vanishing Amphibians

We own a home in the mountains of central Pennsylvania. It has ponds, a small stream with native trout, and numerous seeps. Too rocky for farmland, it is mostly forested. Every year the spring peeper tree frogs would be so loud at times we closed the windows to sleep. Soon any standing water would bubble with tadpoles if approached. But one day about four years ago, I noticed a few dead tadpoles along the water's edge. Over the next week or so, it seemed as if every tadpole had died. The water was littered with corpses. No more ripples when we went to explore. And all were at the same stage of life, when the back legs emerged. How strange! Later I heard of an insidious fungus that was killing frogs the world over. Your article shed a lot of light on the devastation that chytrid brings. These nights I lie awake not to the sound of hundreds of peepers, but straining to hear the call of the few survivors. I only trust 300 million years of evolution have selected some resistance and their offspring will soon lull me to sleep again.

DAN W. JOHNSON
Ashville, Pennsylvania

Geography: What's in an American Name?

The U.S. map framed by American Indian place-names reflects much research and calls our attention to the fact that the area of North America we now call the United States had been settled for thousands of years by American Indian tribal peoples. I'm dismayed that after this research you

My stubborn
neighbors wouldn't
get rid of the
chickens until the
health department
stepped in, placed
rat poison all over
the yards, and
then made them
tear down their
chicken coop.

would state, "The first settlers, who put many European words on the map, also borrowed names from local tribes." Europeans were not the first settlers of North (and South) America. Indian tribal peoples had "settled" this land for thousands of years prior to European "discovery."

MARK WEADICK
Coeur d'Alene, Idaho

Culture: Urban Chickens

I live in the borough of Queens, part of New York City. A few years back my neighbors (who come from Europe) decided to put up a chicken coop and raise chickens in their backyard, right next to mine. As soon as

this coop went up, along with the unbearable smell came the rats. They were taking over my yard so that I could no longer let my children or dog out to play. I set up traps and got rid of many of the rats, but I could no longer control the situation. My stubborn neighbors wouldn't get rid of the chickens until the health department stepped in, placed rat poison all over the yards, and then made them tear down their chicken coop. Having chickens in an urban environment is not to be taken lightly.

A. FALCO
Queens, New York

Photo Journal: Only Women

Scenarios similar to that described at San Pablo Huixtepec, Mexico, were enacted countless times in South Africa only a few years ago. "Independent" homelands—so-called Bantustans—were created, and only men were allowed to work as contract laborers for meager wages in the mines and agricultural industries of white South Africa. Only men were given passes to enter white areas, and their wives, children, and the elderly had to remain in their impoverished homelands. I read that in Mexico the system is called *pura mujer*; in South Africa it was grand apartheid. Perhaps under President Obama, the United States will realize that as its economy and Mexico's appear to be so intertwined, immigration laws that cause such inhumane circumstances must be addressed if America still wishes to be regarded as the leader of the free world.

PHILIP VAN DER SPUY
Simon's Town, South Africa



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Believe It or Not A joyful dog defying gravity, a bird snagging prey—some things have to be seen to be believed. Have you taken an incredible picture? If so, send it our way; your shot might be published in *National Geographic*. Every month this page features two photographs: one chosen by our editors, one chosen by our readers via our online voting machine. For guidelines, a submission form, and more information go to ngm.com/yourshot.



EDITORS' CHOICE

Jason Neely Middletown, Connecticut

"This picture really captures Sidney's personality," says librarian Neely, 34, of his Labrador mix, who leaped through his living room at the first whiff of food. "He's always brimming with enthusiasm and a love for life, as well as treats."

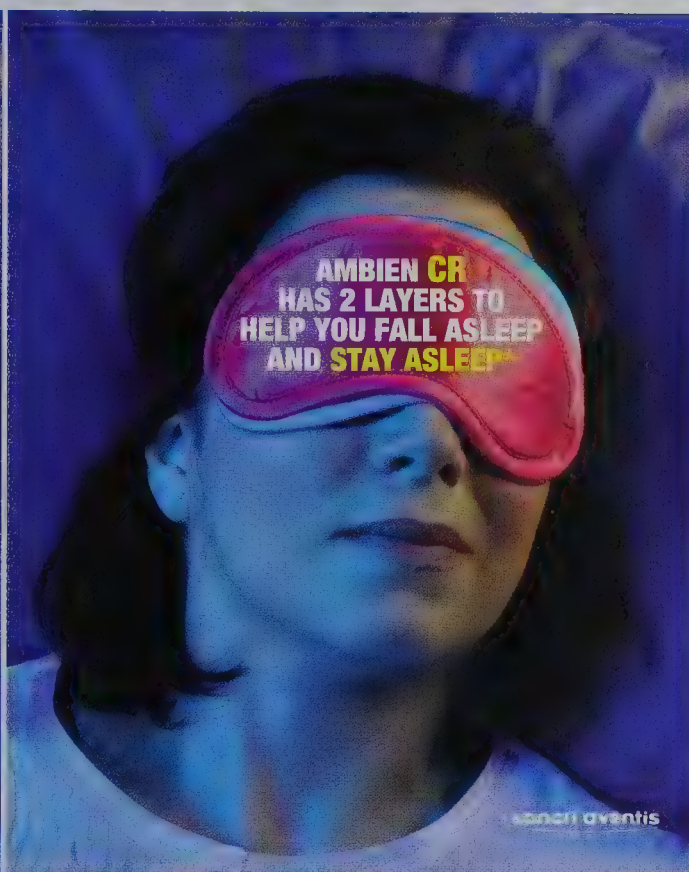
Andy Nguyen Midway City, California

At a Long Beach, California, park, Nguyen, a 42-year-old professional photographer, got a vivid look at one great egret's unorthodox trout-fishing technique.



READERS' CHOICE

THERE ARE 2 FORMS OF AMBIEN® (ZOLPIDEM TARTRATE)©. WHICH ONE IS RIGHT FOR YOU?



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 The first layer dissolves quickly to help you fall asleep fast, while the second dissolves slowly to help you stay asleep*—so you wake up less frequently and fall back to sleep faster. Wake up ready for your day** with 2-layer AMBIEN CR.

There is no generic form of **AMBIEN CR**, so ask your prescriber or pharmacist for **AMBIEN CR** by name.

* Proven effective for up to 7 hours in clinical studies.

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IMPORTANT SAFETY INFORMATION

AMBIEN CR is indicated to help you fall asleep and/or stay asleep.

AMBIEN is indicated for short-term treatment to help you fall asleep.

AMBIEN and AMBIEN CR are treatment options you and your doctor can consider along with lifestyle changes. When taking either of them, don't drive or operate machinery. Plan to devote 7 to 8 hours to sleep before being active. Sleepwalking, and eating or driving while not fully awake, with memory loss for the event, as well as abnormal behaviors such as being more outgoing or aggressive than normal, confusion, agitation, and hallucinations may occur. Don't take it with alcohol as it may increase these

behaviors. In patients with depression, worsening of depression, including risk of suicide may occur. If you experience any of these behaviors contact your doctor immediately.

Allergic reactions such as shortness of breath, swelling of your tongue or throat, may occur and in rare cases may be fatal. If you have an allergic reaction while using AMBIEN or AMBIEN CR, contact your doctor immediately. Side effects of AMBIEN CR may include next-day drowsiness, dizziness and headache. There is a low occurrence of side effects associated with the short-term use of AMBIEN. The most commonly observed side effects in controlled clinical trials were drowsiness, dizziness, and diarrhea.

AMBIEN is taken for 7 to 10 days—or longer as advised by your provider. AMBIEN CR can be taken as long as your doctor recommends. AMBIEN and AMBIEN CR have some risk of dependency. They are non-narcotic.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088.

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MEDICATION GUIDE

AMBIEN CR® (ām'bē-ən see ahr) **C-IV** (*zolpidem tartrate extended-release tablets*)

Read the Medication Guide that comes with AMBIEN CR before you start taking it and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking to your doctor about your medical condition or treatment.

What is the most important information I should know about AMBIEN CR?

After taking AMBIEN CR, you may get up out of bed while not being fully awake and do an activity that you do not know you are doing. The next morning, you may not remember that you did anything during the night. You have a higher chance for doing these activities if you drink alcohol or take other medicines that make you sleepy with AMBIEN CR. Reported activities include:

- driving a car ("sleep-driving")
- making and eating food
- talking on the phone
- having sex
- sleep-walking

Call your doctor right away if you find out that you have done any of the above activities after taking AMBIEN CR.

Important:

1. Take AMBIEN CR exactly as prescribed

- Do not take more AMBIEN CR than prescribed.
- Take AMBIEN CR right before you get in bed, not sooner.

2. Do not take AMBIEN CR if you:

- drink alcohol
- take other medicines that can make you sleepy. Talk to your doctor about all of your medicines. Your doctor will tell you if you can take AMBIEN CR with your other medicines.
- cannot get a full night's sleep

What is AMBIEN CR?

AMBIEN CR is a sedative-hypnotic (sleep) medicine. AMBIEN CR is used in adults for the treatment of a sleep problem called insomnia. Symptoms of insomnia include:

- trouble falling asleep
- waking up often during the night

AMBIEN CR is not for children.

AMBIEN CR is a federally controlled substance (C-IV) because it can be abused or lead to dependence. Keep AMBIEN CR in a safe place to prevent misuse and abuse. Selling or giving away AMBIEN CR may harm others, and is against the law. Tell your doctor if you have ever abused or have been dependent on alcohol, prescription medicines or street drugs.

Who should not take AMBIEN CR?

Do not take AMBIEN CR if you are allergic to anything in it. See the end of this Medication Guide for a complete list of ingredients in AMBIEN CR.

AMBIEN CR may not be right for you. Before starting AMBIEN CR, tell your doctor about all of your health conditions, including if you:

- have a history of depression, mental illness, or suicidal thoughts
- have a history of drug or alcohol abuse or addiction
- have kidney or liver disease
- have a lung disease or breathing problems
- are pregnant, planning to become pregnant, or breastfeeding

Tell your doctor about all of the medicines you take including prescription and nonprescription medicines, vitamins and herbal supplements. Medicines can interact with each other, sometimes causing serious side effects. **Do not take AMBIEN CR with other medicines that can make you sleepy.**

Know the medicines you take. Keep a list of your medicines with you to show your doctor and pharmacist each time you get a new medicine.

How should I take AMBIEN CR?

- Take AMBIEN CR exactly as prescribed. Do not take more AMBIEN CR than prescribed for you.
- **Take AMBIEN CR right before you get into bed.**
- **Do not take AMBIEN CR unless you are able to stay in bed a full night (7-8 hours) before you must be active again.**
- Swallow AMBIEN CR Tablets whole. Do not chew or break the tablets. Tell your doctor if you cannot swallow tablets whole.
- For faster sleep onset, AMBIEN CR should NOT be taken with or immediately after a meal.
- Call your doctor if your insomnia worsens or is not better within 7 to 10 days. This may mean that there is another condition causing your sleep problems.
- If you take too much AMBIEN CR or overdose, call your doctor or poison control center right away, or get emergency treatment.

What are the possible side effects of AMBIEN CR?

Serious side effects of AMBIEN CR include:

- **getting out of bed while not being fully awake and do an activity that you do not know you are doing.** (See "What is the most important information I should know about AMBIEN CR?")
- **abnormal thoughts and behavior.** Symptoms include more outgoing or aggressive behavior than normal, confusion, agitation, hallucinations, worsening of depression, and suicidal thoughts or actions.
- **memory loss**
- **anxiety**
- **severe allergic reactions.** Symptoms include swelling of the tongue or throat, trouble breathing, and nausea and vomiting. Get emergency medical help if you get these symptoms after taking AMBIEN CR.

Call your doctor right away if you have any of the above side effects or any other side effects that worry you while using AMBIEN CR.

The most common side effects of AMBIEN CR are:

- headache
- sleepiness
- dizziness
- You may still feel drowsy the next day after taking AMBIEN CR. **Do not drive or do other dangerous activities after taking AMBIEN CR until you feel fully awake.**

After you stop taking a sleep medicine, you may have symptoms for 1 to 2 days such as: trouble sleeping, nausea, flushing, lightheadedness, uncontrolled crying, vomiting, stomach cramps, panic attack, nervousness, and stomach area pain. These are not all the side effects of AMBIEN CR. Ask your doctor or pharmacist for more information. Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store AMBIEN CR?

- Store AMBIEN CR at room temperature, 59° to 77°F (15° to 25° C).
- **Keep AMBIEN CR and all medicines out of reach of children.**

General Information about AMBIEN CR

- Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide.
- Do not use AMBIEN CR for a condition for which it was not prescribed.

- Do not share AMBIEN CR with other people, even if you think they have the same symptoms that you have. It may harm them and it is against the law.

This Medication Guide summarizes the most important information about AMBIEN CR. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about AMBIEN CR that is written for healthcare professionals. For more information about AMBIEN CR, call 1-800-633-1610 or visit www.ambienr.com.

What are the ingredients in AMBIEN CR?

Active Ingredient: Zolpidem tartrate

Inactive Ingredients: The 6.25 mg tablets contain: colloidal silicon dioxide, hypromellose, lactose monohydrate, magnesium stearate, microcrystalline cellulose, polyethylene glycol, potassium bitartrate, red ferric oxide, sodium starch glycolate, and titanium dioxide. The 12.5 mg tablets contain: colloidal silicon dioxide, FD&C Blue #2, hypromellose, lactose monohydrate, magnesium stearate, microcrystalline cellulose, polyethylene glycol, potassium bitartrate, sodium starch glycolate, titanium dioxide, and yellow ferric oxide.

Rx Only

This Medication Guide has been approved by the U.S. Food and Drug Administration.

sanofi-aventis U.S. LLC

Bridgewater, NJ 08807

January 2008a

AMBCR-JAN08a-M-Ab

MEDICATION GUIDE

AMBIEN® (ām'bē-ən) Tablets C-IV (zolpidem tartrate)

Read the Medication Guide that comes with AMBIEN before you start taking it and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking to your doctor about your medical condition or treatment.

What is the most important information I should know about AMBIEN?

After taking AMBIEN, you may get up out of bed while not being fully awake and do an activity that you do not know you are doing. The next morning, you may not remember that you did anything during the night. You have a higher chance for doing these activities if you drink alcohol or take other medicines that make you sleepy with AMBIEN. Reported activities include:

- driving a car ("sleep-driving")
- making and eating food
- talking on the phone
- having sex
- sleep-walking

Call your doctor right away if you find out that you have done any of the above activities after taking AMBIEN.

Important:

1. Take AMBIEN exactly as prescribed

- Do not take more AMBIEN than prescribed.
- Take AMBIEN right before you get in bed, not sooner.

2. Do not take AMBIEN if you:

- drink alcohol
- take other medicines that can make you sleepy. Talk to your doctor about all of your medicines. Your doctor will tell you if you can take AMBIEN with your other medicines.
- cannot get a full night's sleep

What is AMBIEN?

AMBIEN is a sedative-hypnotic (sleep) medicine. AMBIEN is used in adults for the short-term treatment of a sleep problem called insomnia. Symptoms of insomnia include:

- trouble falling asleep

AMBIEN is not for children.

AMBIEN is a federally controlled substance (C-IV) because it can be abused or lead to dependence. Keep AMBIEN in a safe place to prevent misuse and abuse. Selling or giving away AMBIEN may harm others, and is against the law. Tell your doctor if you have ever abused or have been dependent on alcohol, prescription medicines or street drugs.

Who should not take AMBIEN?

Do not take AMBIEN if you are allergic to anything in it.

See the end of this Medication Guide for a complete list of ingredients in AMBIEN.

AMBIEN may not be right for you. Before starting AMBIEN, tell your doctor about all of your health conditions, including if you:

- have a history of depression, mental illness, or suicidal thoughts
- have a history of drug or alcohol abuse or addiction
- have kidney or liver disease
- have a lung disease or breathing problems
- are pregnant, planning to become pregnant, or breastfeeding

Tell your doctor about all of the medicines you take including prescription and nonprescription medicines, vitamins and herbal supplements. Medicines can interact with each other, sometimes causing serious side effects. **Do not take AMBIEN with other medicines that can make you sleepy.**

Know the medicines you take. Keep a list of your medicines with you to show your doctor and pharmacist each time you get a new medicine.

How should I take AMBIEN?

- Take AMBIEN exactly as prescribed. Do not take more AMBIEN than prescribed for you.
- **Take AMBIEN right before you get into bed.**
- **Do not take AMBIEN unless you are able to stay in bed a full night (7-8 hours) before you must be active again.**
- For faster sleep onset, AMBIEN should NOT be taken with or immediately after a meal.
- Call your doctor if your insomnia worsens or is not better within 7 to 10 days. This may mean that there is another condition causing your sleep problem.
- If you take too much AMBIEN or overdose, call your doctor or poison control center right away, or get emergency treatment.

What are the possible side effects of AMBIEN?

Serious side effects of AMBIEN include:

- **getting out of bed while not being fully awake and do an activity that you do not know you are doing.** (See “What is the most important information I should know about AMBIEN?”)
- **abnormal thoughts and behavior.** Symptoms include more outgoing or aggressive behavior than normal, confusion, agitation, hallucinations, worsening of depression, and suicidal thoughts or actions.
- **memory loss**
- **anxiety**
- **severe allergic reactions.** Symptoms include swelling of the tongue or throat, trouble breathing, and nausea and vomiting. Get emergency medical help if you get these symptoms after taking AMBIEN.

Call your doctor right away if you have any of the above side effects or any other side effects that worry you while using AMBIEN.

The most common side effects of AMBIEN are:

- drowsiness
- dizziness
- diarrhea
- “drugged feelings”
- You may still feel drowsy the next day after taking AMBIEN. **Do not drive or do other dangerous activities after taking AMBIEN until you feel fully awake.**

After you stop taking a sleep medicine, you may have symptoms for 1 to 2 days such as: trouble sleeping, nausea, flushing, lightheadedness, uncontrolled crying, vomiting, stomach cramps, panic attack, nervousness, and stomach area pain.

These are not all the side effects of AMBIEN. Ask your doctor or pharmacist for more information.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store AMBIEN?

- Store AMBIEN at room temperature, 68° to 77°F (20° to 25°C).
- **Keep AMBIEN and all medicines out of reach of children.**

General Information about AMBIEN

- Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide.
- Do not use AMBIEN for a condition for which it was not prescribed.
- Do not share AMBIEN with other people, even if you think they have the same symptoms that you have. It may harm them and it is against the law.

This Medication Guide summarizes the most important information about AMBIEN. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about AMBIEN that is written for healthcare professionals. For more information about AMBIEN, call 1-800-633-1610.

What are the ingredients in AMBIEN?

Active Ingredient: Zolpidem tartrate

Inactive Ingredients: hydroxypropyl methylcellulose, lactose, magnesium stearate, micro-crystalline cellulose, polyethylene glycol, sodium starch glycolate, and titanium dioxide. In addition, the 5 mg tablet contains FD&C Red No. 40, iron oxide colorant, and polysorbate 80.

Rx Only

This Medication Guide has been approved by the U.S. Food and Drug Administration.

sanofi-aventis U.S. LLC
Bridgewater, NJ 08807

June 2008

AMB-JUNE08-F-Ac

AMERICA'S FIRST SILVER DOLLAR



Own the Dollar that helped Win America's Independence!

Most Americans would expect to see an authentic Revolutionary War treasure from the 1700's only behind glass in a museum. Now, thanks to a recent discovery of these coins in a centuries old shipwreck, you can actually own America's First Silver Dollar!

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Struck in the New World between 1772 and 1821 in 90.3% fine silver, these Spanish colonial "8 Royals" were authorized by the Continental Congress upon the recommendation of Thomas Jefferson as America's first official coinage. Widely circulated throughout the 13 Colonies, they were used to help fund the American Revolutionary War and earned the title of "America's First Silver Dollar."

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Accepted as legal tender in the U.S. until 1857, each of these hefty silver dollars weighs 27 grams and is 39 mm in diameter. From Europe to China, throughout the Caribbean, and across the 13 Colonies, these silver dollars were readily accepted for trade due to their heft and high silver value.

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VISIONS OF EARTH

Pakistan Women and children await registration and relief at the Jalojai refugee camp. Since last summer, some one million Pakistanis have fled the fighting between the military and militants near the Afghan border.

PHOTO: EMILIO MORENATTI, AP IMAGES



Greenland Eight hundred miles south of the North Pole, a cavern of stalactite-like stratus clouds—churned by 90-mile-an-hour winds—and the light of a bruised dawn paint an apocalyptic portrait over Inglefield Bay.



PHOTO: BRYAN AND CHERRY ALEXANDER



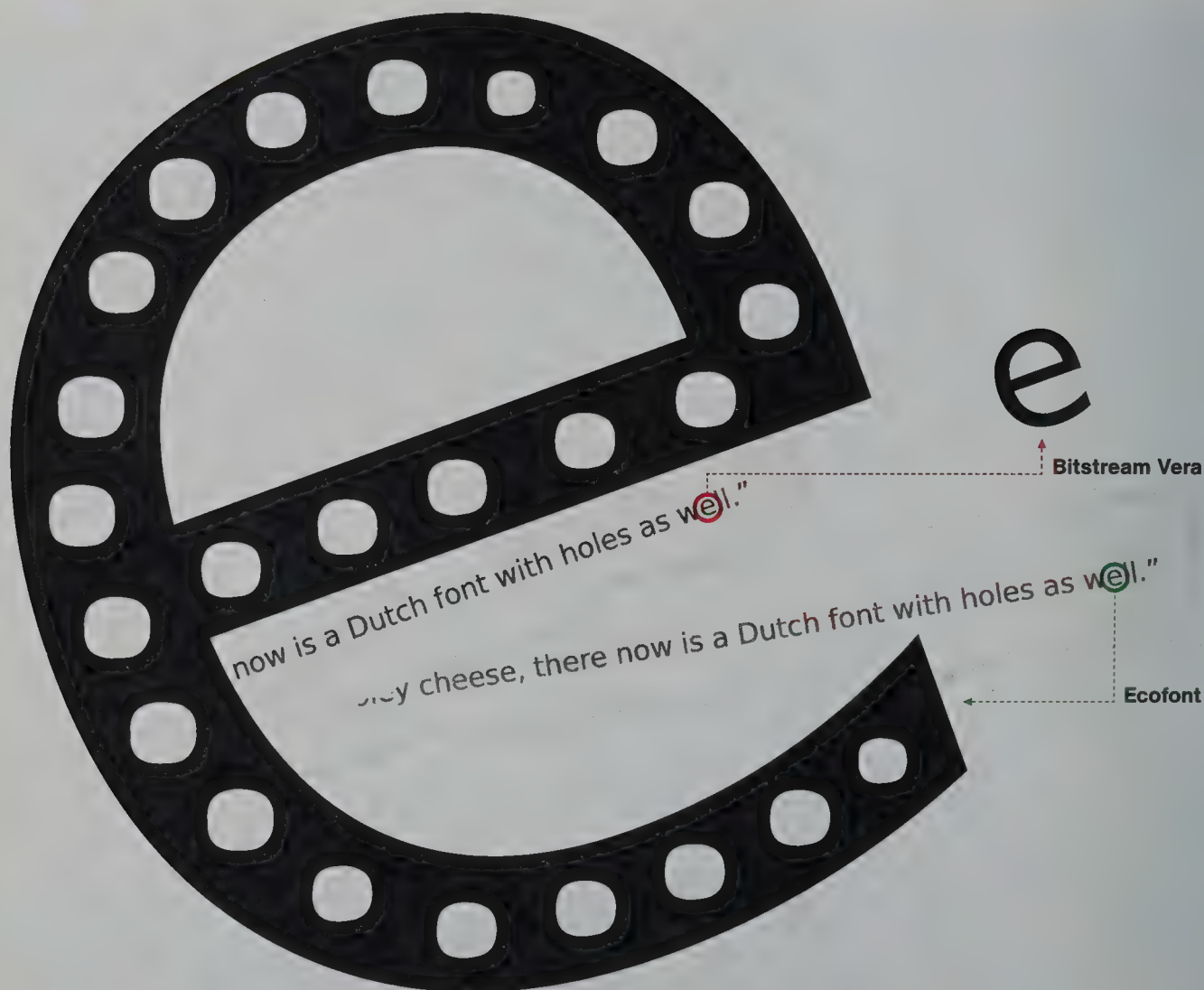
Mexico Thirteen feet and a thousand-plus pounds of great white shark bump a diver's cage and roil the waters off Guadalupe Island. The region, rich in seal and sea lion rookeries, is a hot spot for the powerful predators.



➤ Order prints of *National Geographic* photos online at **PrintsNGS.com**.

PHOTO: BRANDON COLE





LESS IS MORE

Based on a typeface called Bitstream Vera, the Ecofont tends to look best at about 10 points—a bit bigger than the words in the main text on this page. It can be downloaded for free at ecofont.eu.

Holey Grail Are you a green type? The new Ecofont, from the Dutch marketing firm Spranq, aims to be one. Co-owner Alexander Kraaij says it uses less ink than other typefaces, thus saving money and resources. In fact, he contends, a company with 5,000 workers could trim up to \$125,000 a year from its printing costs.

The circles are the secret. Spranq found that if it used rounded holes—stars and stripes were too conspicuous—a fifth of a 10-point, Verdana-like letter could be removed without ruining readability. Savings shrink at smaller sizes; holes are obvious at larger ones.

Still, legibility isn't the same as likability. Font scholar Frank Romano dismisses the Ecofont as a gimmick, unsuitable for serif typefaces and inexact ink-jet printers. He also thinks its cheeselike holes are an eyesore: "If I wanted Swiss type, I would use Helvetica."

Kraaij says that's hardly the point. While a professional, multi-alphabet Ecofont is available for publishing, the original is intended primarily for home and internal office jobs. "Even if its use is limited," says Alissa Levin of Manhattan's Point Five Design, "it makes you think hard about ink, not just paper and printers." —Jeremy Berlin

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to only 2500 Orders!



How's This For a Stimulus Package? FREE Ruby Pendant for the First 2500 Responders

Our gift to you: A one carat radiant, lab-created ruby pendant

Here's some important news that will affect your bank account. But it's good news, for a change. You see, while Congress was busy cutting billion dollar checks to the banks and big corporations, we concocted our own bailout plan. And ours won't cost the taxpayer a dime and looks a million times better with a cocktail dress.

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This is no joke. There is no catch. Simply call our toll-free number or log on to www.stauer.com. The first 2500 to respond to this ad will get the *Scienza™* lab-created *Ruby Pendant* absolutely **FREE**. If you're wondering exactly how we can afford to do this... read on.

Why give away jewelry? Our real goal is to build a long term relationship with you. We are convinced you will become a loyal Stauer client in the years to come. But for now, in this lousy economy, offering this remarkable pendant seemed the best way for you to give us a try.

The *Scienza™ Ruby Pendant* features an impressive 1-carat oval-cut, lab-created ruby prong-set in luxurious gold vermeil. Surrounding the radiant red oval are 14 brilliant-cut, lab-created *DiamondAura®* dazblers. The combination sparkles with a passionate fire that is even brighter than most mined stones.

The world's most valuable gemstone. For thousands of years, the luxury of natural rubies has been coveted by pharaohs, emperors and royalty from all continents. Known as the "king of all precious stones," the red glow of a ruby symbolizes love, life and desire. But such beauty can come at a steep price and even today, rubies remain some of the most expensive gems on Earth.

Can science really improve nature?

The right chemistry is vital in any romantic relationship. We had to get it perfect. That's why the gemologists worked for years to create the world's most romantic, most colorful lab-created ruby. Our *Scienza™* are scientifically grown, crafted in laboratories with precise equipment that recreates the high pressures and heat that nature uses to produce gemstones far beneath the surface of the earth. *Scienza™* are chemically identical to the natural gemstone in hardness and display a better color and sparkle than most mined corundum.

But mined rubies can cost up to \$5,000 per carat for this level of color and clarity! The *Scienza™* originates from an ingenious process that lets you experience the seductive fire of priceless gems without the exorbitant cost. You pay nothing except basic shipping and processing costs of \$25.²⁵, the normal shipping fee for a \$200-\$300 pendant

It's okay to be skeptical. But the truth is that Stauer doesn't make money by selling one piece of jewelry to you on a single occasion. Our success comes from serving our long term clients. Be one of the first 2500 to respond to this ad and receive 100% off while getting a closer look at Stauer's exclusive selection of fine jewelry.

JEWELRY SPECS:

- 1 carat 5mm x 7mm lab-created, oval-faceted ruby
- 1/5 ctw white *DiamondAura®* - Gold vermeil setting

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Smart Luxuries—Surprising Prices

Full Tilt Of all Pisa's leaning towers—yes, there are several—the famous one is the least likely to topple. That's because an 11-year restoration effort, involving three years of painstaking soil removal, has successfully steadied the precariously poised campanile.

Pisa's soil is mostly compressible clay and sand, which gives way over time and causes big buildings to shift. The iconic edifice started listing northward during its first phase of construction, in the 1100s, then changed course, pitching southward over the next eight centuries.

An 1817 measurement put its incline at 5 degrees; by 1990, the cant had increased to 5.5. Fearing the 197-foot-tall, tourist-luring monument might collapse, Italy's premier formed an international team to preserve it.

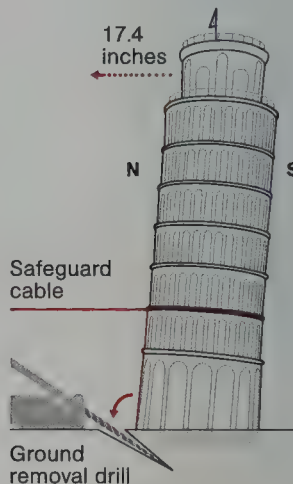
John Burland, a top project engineer, says the tower's tilt is back to 5 degrees, and "over the last two years, almost no movement has been detected." The city's other bell towers, though linked to larger structures, haven't been bolstered. One hopes the Leaning Tower of Pisa won't someday be the Only Tower of Pisa. —Catherine L. Barker

Pisa
ITALY
Rome

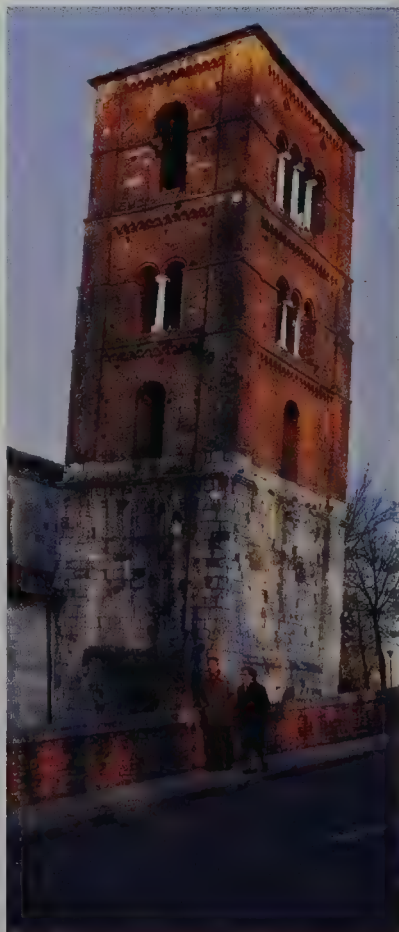
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STRAIGHT STORIES

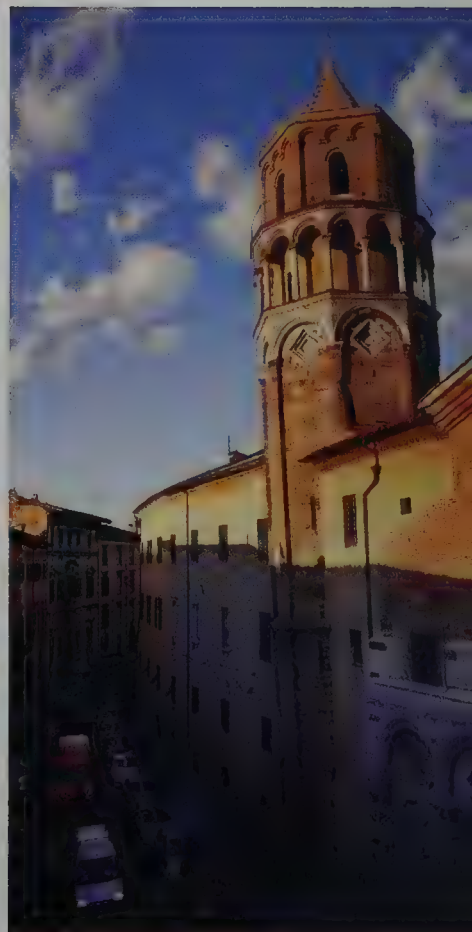
Drilling in 41 places helped level the base, which shifted the tower top nearly 1.5 feet.



La Torre di Pisa
Year completed: circa 1370
Tilt: 5 degrees



San Michele degli Scalzi
Year completed: circa 1100
Tilt: 5 degrees



San Nicola
Year completed: circa 1250
Tilt: 2.5 degrees

South
China
Sea

Pacific
Ocean

PHILIPPINES

Palawan Hornbill (*Anthracoceros marchei*)

Size: Head and body length, 55 - 65 cm (21.7 - 25.6 inches) **Weight:** 601 - 713 g (1.3 - 1.6 lbs)

Habitat: Primary and secondary evergreen forest; also found in mangrove swamps and cultivated areas

Surviving number: Estimated at 2,500 - 10,000



Photographed by Kurt W. Baumgartner

WILDLIFE AS CANON SEES IT

The forest has a friend. The Palawan hornbill fulfills that role beautifully thanks to its dining habits. It gathers fruits in a gular pouch, then processes and spits out seeds where they are able to thrive, away from the competing parent tree. Living in pairs or small groups, the hornbill nests in large trees and ranges from undergrowth to canopy. But trees are in shorter and shorter supply these days — three islands in the hornbill's range are now

largely deforested. With the forest disappearing, poaching persisting and eggs and young being captured for pets or food, the hornbill needs some friends of its own if it is to have a future.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.

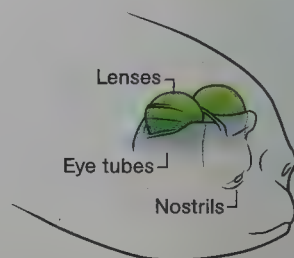
Canon



This four-inch *Macropinna microstoma*, aglow from submersible lights, sports a transparent top to guard its shifty eyes.

Eyes That Surprise Two thousand feet down lurks the baffling barreleye. What look to be its eyes are nostrils. Its real eyes are tubes topped by green lenses adapted to catch light and let the fish judge the gap from mouth to meal. (The pigment filters downwelling light, making prey easier to see.) On top, a fluid-filled dome shields the eyes from stinging animals without blocking the view.

Until recently scientists thought those baby greens were locked in place, compounding a problem caused by their shape: extreme tunnel vision. But this created a paradox. How does a fish that can only look up nab prey with a mouth that faces front? Now, with video and specimens captured from 2,000 feet below by a remotely operated vehicle, Bruce Robison and Kim Reisenbichler of the Monterey Bay Aquarium Research Institute have solved the puzzle: The eyes are actually quite mobile. In the “up” (default) position they track food, such as krill falling from above. Then, muscles twitch and pop the eyes forward to help the fish aim its bite. A barreleye also cruises under jellies, eyeing food caught in their tentacles. Choosing a target, it swings its body vertical and its eyes front, then swipes the spoils. Like many deep-sea occupants, these fish seem downright peculiar when examined up close, says Robison. “But they’re actually nicely suited to the lives they lead.” —Jennifer S. Holland



STRANGE SIGHT

The barreleye's eyes can flit forward. Muscles outside the tubes make the shift possible.

HISTORIC SIGNIFICANCE.
TIMELESS BEAUTY.



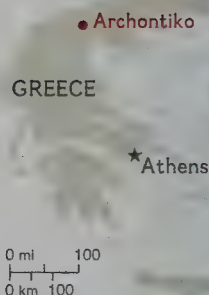
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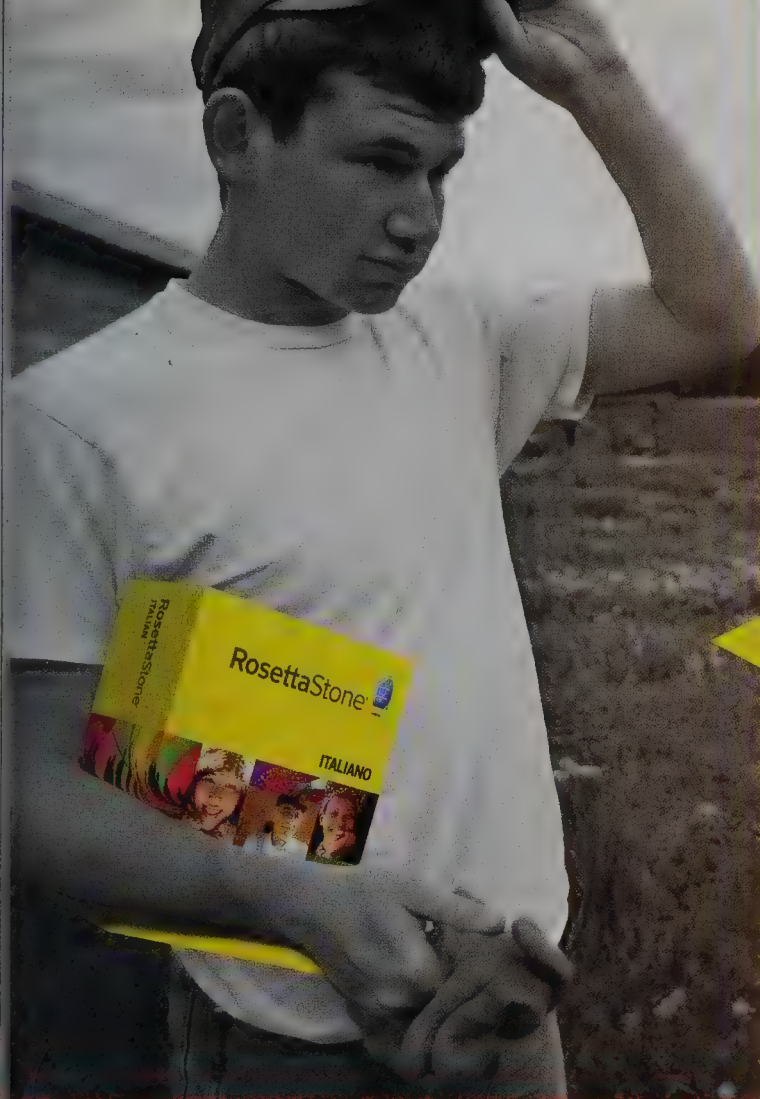
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Cradle of a Legend Graves laden with luxuries offer a revealing new look at the wealthy military culture that gave birth to Alexander the Great. Excavations in Archontiko have uncovered 450 tombs from the sixth century B.C. Archaeologists Pavlos and Anastasia Chrysostomou, of the Greek Ministry of Culture, describe scores of warriors whose armor, swords, and shoes sparkled with gold and silver as well as noblewomen adorned with gold, silver, amber, and faience. Other funerary items—a scarab from Egypt, ceramics from the eastern Mediterranean—foreshadow the empire that the fabled Macedonian general would conquer 200 years later. —A. R. Williams



A gold mask and gold-trimmed helmet, seen here on a mannequin, were found in a Macedonian warrior's grave.





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Death Knell In the early 1800s an Englishman could be hanged for stealing a shirt. By the end of the 1900s, growing concern for individual rights had caused the death penalty to disappear from the United Kingdom and nearly everywhere else in the Western world. Two exceptions are Belarus and the United States, although this year New Mexico became the 15th state to outlaw capital punishment. Death-penalty opponents cite the exoneration of 131 people on death row since 1973 as well as the high cost of capital cases.

Defenders argue that the penalty offers justice and cite some studies that show it's a deterrent. The practice is strong in culturally conservative areas—Japan, Saudi Arabia, Texas—and totalitarian regimes.

Elsewhere, opposition is mounting. Indian activists believe capital punishment is a violation of the right to life (left). In most countries where

the penalty is still on the books, it is used less and less, notes Piers Bannister of Amnesty International's London office. He believes global opinion will eventually bring an end to executions. "Not in my lifetime," says Bannister, 47, "but in my children's." —Karen E. Lange



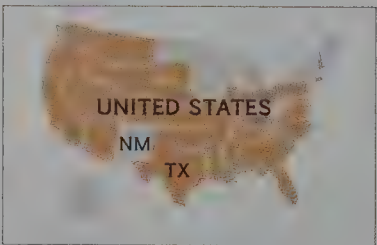
DEATH ROWS

In 2008 there were official reports of 2,390 executions in 25 countries.

2,390	China
1,718	China
346	Iran
102	Saudi Arabia
37	United States
36	Pakistan
34	Iraq
19	Vietnam
17	Afghanistan
15	North Korea
15	Japan
13	Yemen
10	Indonesia
8	Libya
5	Bangladesh
4	Belarus
2	Egypt
1 each	Bahrain, Botswana, Malaysia, Mongolia, St. Kitts and Nevis, Singapore, Sudan, Syria, United Arab Emirates



PENAL MODE Only 56 countries, plus Taiwan and the Palestinian territories, apply the death penalty for civilian, peacetime crimes (map, in orange). Another 36 countries have the law on the books but no longer use it.



Of the 35 states with a death penalty, some have a moratorium on its use.

"During my many years as a jeweler, examining an astonishing 20 ctw emerald necklace certainly is a rare treat. The Stauer Emerald in Gold Necklace is as good as it gets."

*— JAMES T. FENT, Stauer
GIA Graduate Gemologist*



*20 carats of genuine
mined emeralds.
Enlarged to show details*

The Curse of the Perfect Gift

20 carats of polished natural emeralds linked with 14K gold for under \$200!

It happened on our last trip to South America. After visiting the "Lost City" of Machu Picchu in Peru, we ventured through the mountains and down the Amazon into Brazil. In an old village we met a merchant with an impressive collection of spectacular, iridescent emeralds. Each gem was tumbled smooth and glistened like a perfect rain forest dew drop. But the price was so unbelievable, I was sure our interpreter had made a mistake.

But there was no mistake. And after returning home, I had 20 carats of these exquisite emeralds strung up in 14k gold and wrapped as a gift for my wife's birthday. That's when my trouble began. She loved it. Absolutely adored it. In fact, she rarely goes anywhere without the necklace and has basked in compliments from total strangers for months now.

So what's the problem? I'm never going to find an emerald deal this good again. In giving her such a perfect gift, I've made it impossible to top myself.

To make matters worse, my wife's become obsessed with emeralds. She can't stop sharing stories about how Cleopatra cherished the green gem above all others and how emeralds were worshiped by the Incas and Mayans and prized by Spanish conquistadors and Indian maharajahs. She's even buying into ancient beliefs that emeralds bring intelligence, well-being and good luck to anyone who wears them. I don't have the heart to tell her that I'm never going to find another deal this lucky.



*Complete your collection
with the 5 ctw Emerald
in 14K Gold Earrings.*

Our elegant Emeralds in 14K Gold Necklace features 20 carats of smooth, round emerald beads, hand-wired together with delicate 14K gold links. Each bead is unique in both size and color, ranging from transparent to translucent. The 18" necklace fastens with a spring ring clasp. If you are not thrilled at this rare find, send it back within 30 days for a full refund of the purchase price. But remember, we have only found enough emeralds to make a small limited number of necklaces and earrings at this low price.

JEWELRY SPECS:

- 20 ctw of polished natural emeralds
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Emeralds in 14K Gold Necklace

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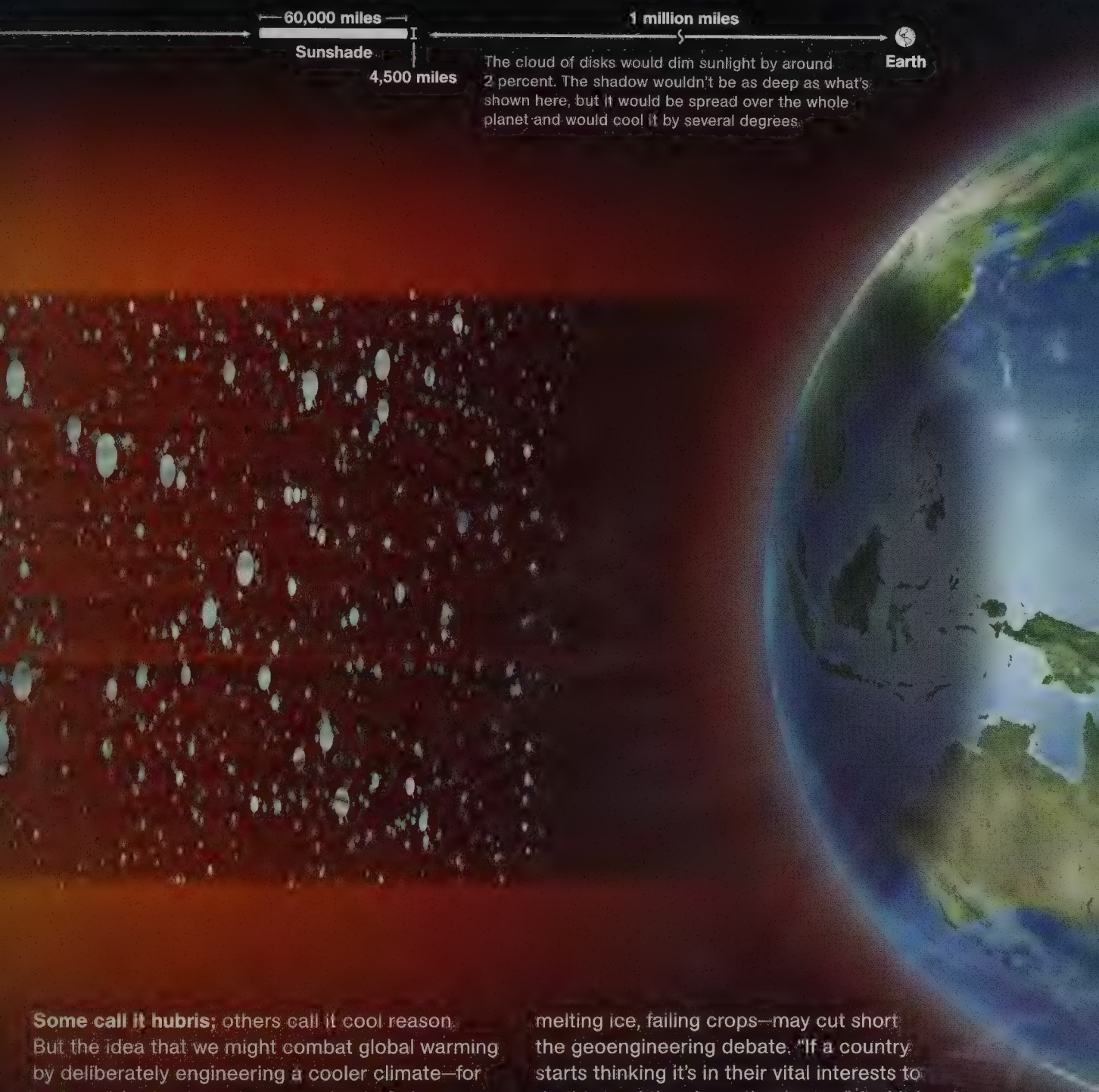
Sun

92 million miles

Astronomer Roger Angel has proposed a far-out sunshade: trillions of two-foot-wide sun deflectors orbiting a million miles from Earth.

Shading the Earth

If we don't cut fossil fuels fast enough, global warming may get out of hand. Some scientists say we need a plan B: a giant sunshade that would cool the whole planet.



Some call it hubris; others call it cool reason. But the idea that we might combat global warming by deliberately engineering a cooler climate—for instance, by constructing some kind of planetary sunshade—has lately migrated from the fringe to the scientific mainstream. We are already modifying climate by accident, say proponents of geoengineering; why not do something intentional and intelligent to stop it? Hold on, say critics. Global warming shows we understand the Earth too little to engineer it without unintended and possibly disastrous consequences. Both sides worry that facts on the ground—rising seas,

melting ice, failing crops—may cut short the geoengineering debate. “If a country starts thinking it’s in their vital interests to do this, and they have the power, I find it hard to imagine them not doing it,” says Ken Caldeira, a climate expert at the Carnegie Institution.

Caldeira is talking about the easiest, cheapest form of geoengineering: building a sunshade in the stratosphere out of millions of tons of tiny reflective particles, such as sulfate. Planes, balloons, battleship guns pointed upward—there is no shortage of possible delivery vehicles. And there is little doubt you could cool Earth

**IMAGINE THIS BLISTERING RASH
ALONG WITH STABBING PAIN**



**AND YOU'LL HAVE AN IDEA
WHAT IT CAN BE LIKE TO HAVE SHINGLES**



For more information on the availability of ZOSTAVAX through the Merck Vaccine Patient Assistance Program, visit ZOSTAVAX.com/freevaccines or call 1-877-9 SHINGLES.

IF YOU HAD CHICKENPOX AS A CHILD, YOU COULD GET SHINGLES NOW.

The chickenpox virus is still in your body.

It can resurface as Shingles, a painful, blistering rash. The Shingles rash usually lasts up to 30 days, and for most the pain lessens as the rash heals. But some people who develop Shingles experience long-term pain that can last for months, even years.

ZOSTAVAX is the only vaccine that can prevent Shingles.

ZOSTAVAX is used to prevent Shingles in adults 60 years of age or older. Once you reach age 60, the sooner you get vaccinated, the better your chances of protecting yourself from Shingles. ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles once you have it. Talk to your health care professional to see if ZOSTAVAX is right for you.

Important Safety Information

ZOSTAVAX may not fully protect everyone who gets the vaccine. You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin and neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. Possible side effects include redness, pain, itching, swelling, warmth, or bruising at the injection site, as well as headache. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088. Before getting vaccinated, talk to your health care professional about situations you may need to avoid after getting ZOSTAVAX. Please see the Patient Product Information on the adjacent page.

Before you get Shingles, ask about ZOSTAVAX.

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Zoster Vaccine Live

www.zostavax.com

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**Patient Information about
ZOSTAVAX® (pronounced "ZOS tah vax")
Generic name: Zoster Vaccine Live**

You should read this summary of information about ZOSTAVAX* before you are vaccinated. If you have any questions about ZOSTAVAX after reading this leaflet, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 60 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles. If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people.

ZOSTAVAX may not protect everyone who gets the vaccine. ZOSTAVAX cannot be used to treat shingles once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including nonprescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, warmth, or bruising where the shot was given.
- headache.

The following additional side effects have been reported in general use with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- fever.
- rash.
- swollen glands near the injection site (that may last a few days to a few weeks).

Tell your health care provider if you have any new or unusual symptom after you receive ZOSTAVAX.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

What else should I know about ZOSTAVAX?

Vaccinees and their health care providers are encouraged to call 1-800-986-8999 to report any exposure to ZOSTAVAX during pregnancy.

This leaflet summarizes important information about ZOSTAVAX.

If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

Rx only

Issued December 2008

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Mount Pinatubo's cloud of ash and pumice was deadly, but the whole Earth was cooled by its sulfur.

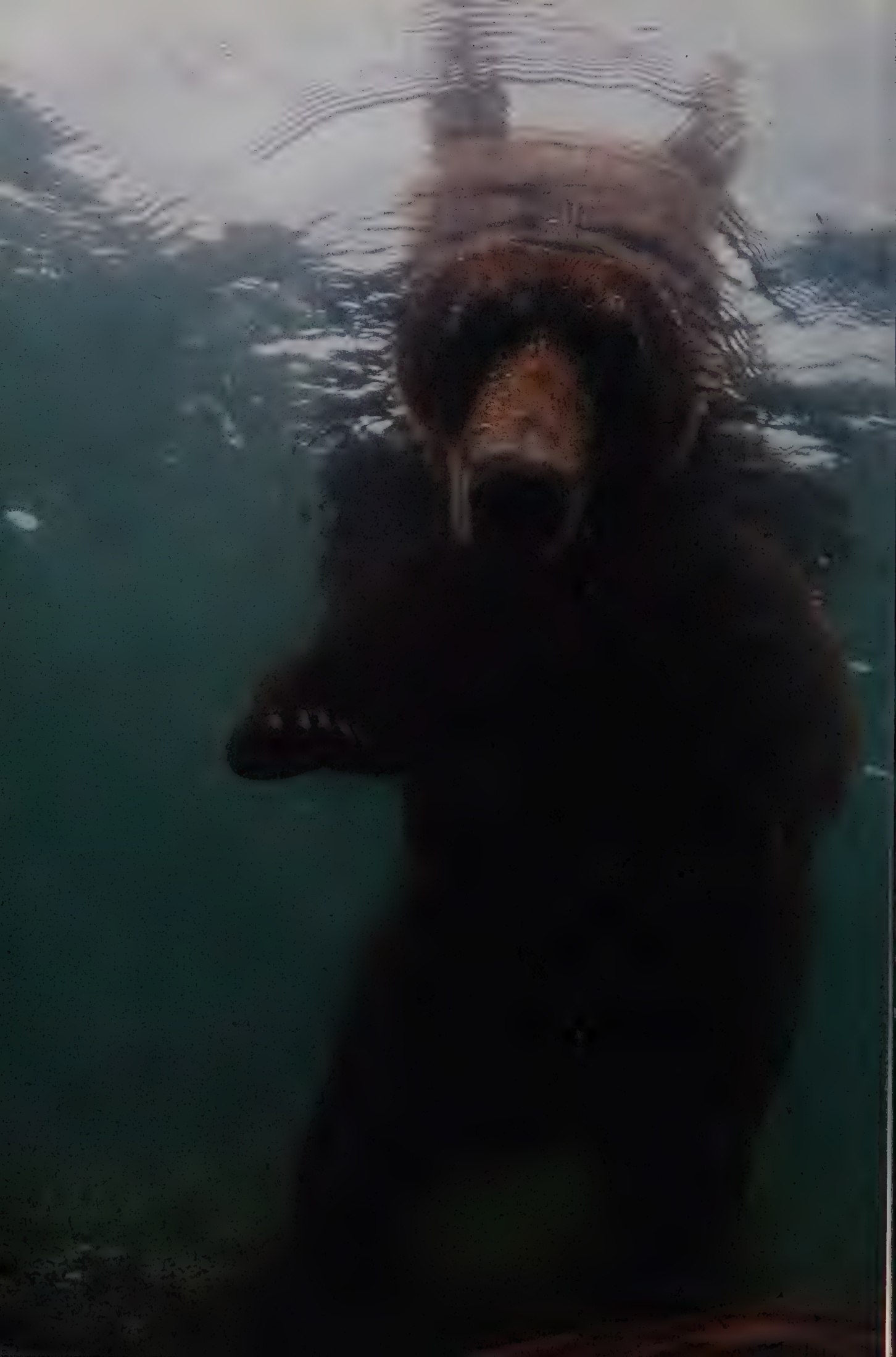
that way, because volcanoes already do it. After Mount Pinatubo erupted in the Philippines in 1991, launching ten million tons of sulfur into the stratosphere and spreading a sun-dimming haze around the planet, the average temperature dropped by about a degree Fahrenheit for a year. With carefully designed particles, geoengineers might make do with a fraction of that tonnage—though because they fall out of the stratosphere, the particles would have to be delivered continually, year after year. Still, says Caldeira, the sulfate scheme would be “essentially free compared with the other costs of mitigating climate change.”

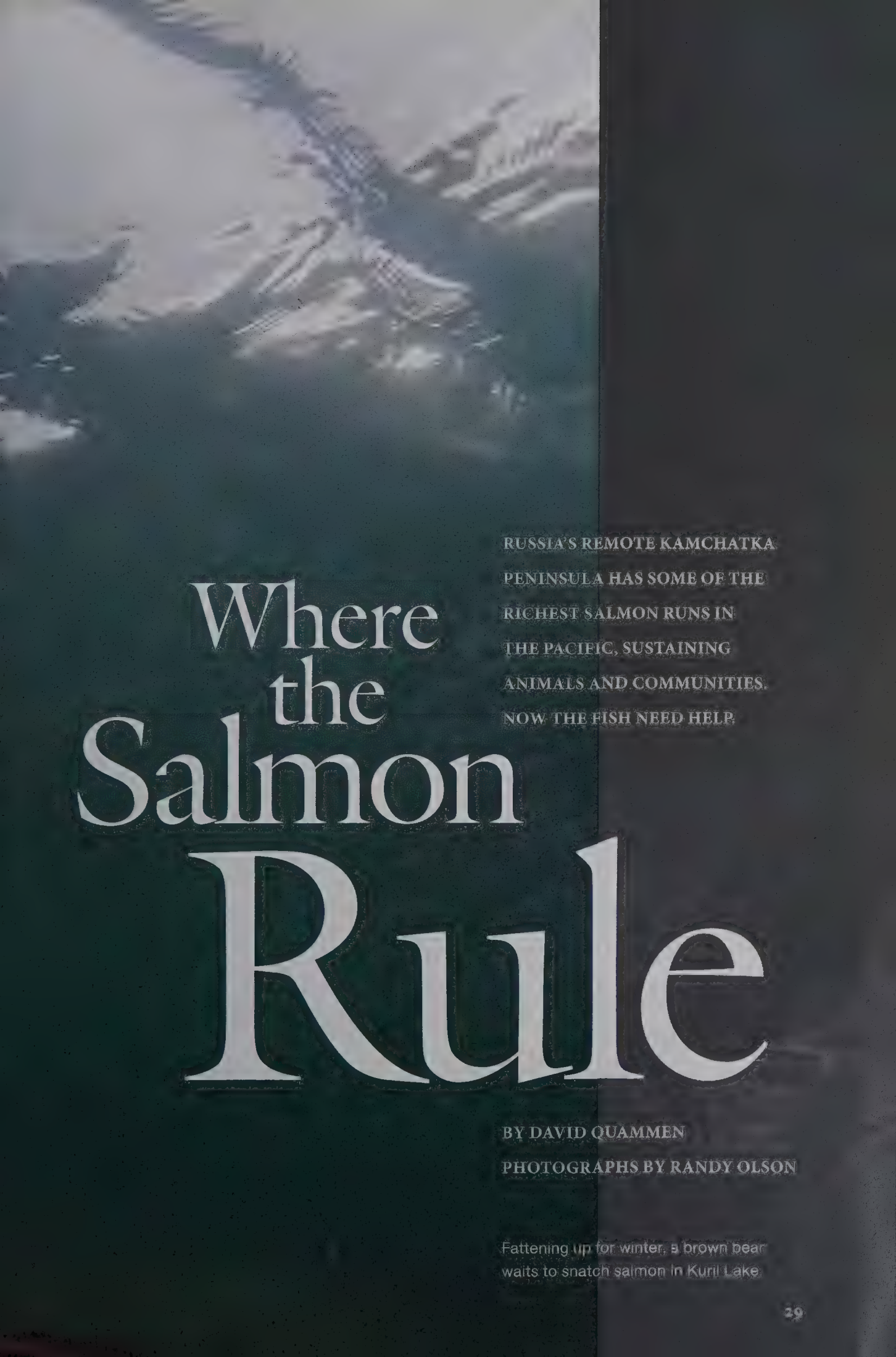
Not so the idea suggested by Roger Angel, an eminent astronomer and telescope designer at the University of Arizona. Angel has proposed launching trillions of two-foot-wide, thinner-than-Kleenex disks of silicon nitride—each disk an autonomous robot weighing less than a gram—into space between Earth and the sun, where they could deflect sunlight. By Angel's own reckoning, the scheme would take decades and cost trillions

of dollars. With that much time and money, we could wean ourselves from fossil fuels and actually solve the climate problem—by far the better outcome, as Angel and most proponents of geoengineering would agree. Unfortunately, though the recession has temporarily slowed the rise in carbon dioxide emissions, we've made no real progress toward that goal. Some say we're running out of time.

If we put up a sunshade without restraining emissions and the sunshade later fails, the climate accident would become a train wreck: The global warming we'd been masking would come rushing at us all at once. That might be the worst unintended consequence of geoengineering, but there could be others—damage to the ozone layer, perhaps, or an increase in drought. If CO₂ keeps rising, though, we may face greater emergencies. And what once seemed insane hubris just might become reality. —Robert Kunzig

➤ **Good or bad idea?** Vote online at ngm.com/bigidea.





Where the Salmon Rule

RUSSIA'S REMOTE KAMCHATKA
PENINSULA HAS SOME OF THE
RICHEST SALMON RUNS IN
THE PACIFIC, SUSTAINING
ANIMALS AND COMMUNITIES.
NOW THE FISH NEED HELP.

BY DAVID QUAMMEN

PHOTOGRAPHS BY RANDY OLSON

Fattening up for winter, a brown bear
waits to snatch salmon in Kuril Lake.



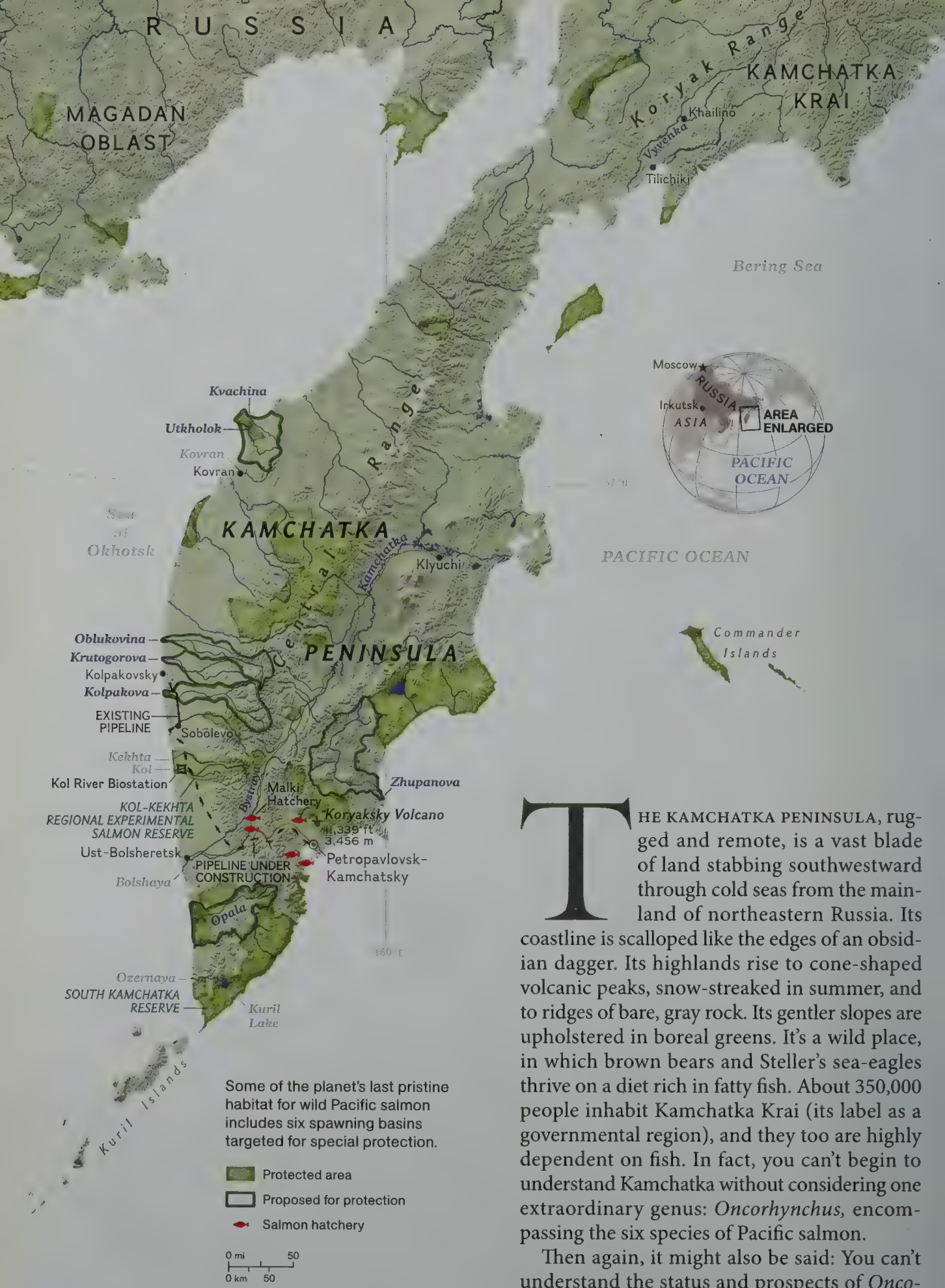


Six Pacific salmon species migrate back to Kamchatka to spawn, their shapes and colors changing dramatically as they move into fresh water. Sockeye, the most valuable kind, dominates traffic in the Ozeraya River.



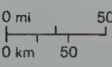
Trucker Yuri Krechetov will haul a load of these coho to a nearby processing plant. Females are gutted for their eggs, sold as caviar. Despite quotas on Kamchatka's catch, widespread corruption stymies enforcement.





Some of the planet's last pristine habitat for wild Pacific salmon includes six spawning basins targeted for special protection.

- Protected area
- Proposed for protection
- Salmon hatchery



THE KAMCHATKA PENINSULA, rugged and remote, is a vast blade of land stabbing southwestward through cold seas from the mainland of northeastern Russia. Its coastline is scalloped like the edges of an obsidian dagger. Its highlands rise to cone-shaped volcanic peaks, snow-streaked in summer, and to ridges of bare, gray rock. Its gentler slopes are upholstered in boreal greens. It's a wild place, in which brown bears and Steller's sea-eagles thrive on a diet rich in fatty fish. About 350,000 people inhabit Kamchatka Krai (its label as a governmental region), and they too are highly dependent on fish. In fact, you can't begin to understand Kamchatka without considering one extraordinary genus: *Oncorhynchus*, encompassing the six species of Pacific salmon.

Then again, it might also be said: You can't understand the status and prospects of *Oncorhynchus* on Earth without considering Kamchatka, the secret outback where at least 20



Wares for far eastern Russia—like flashy Chinese-made shoes worn by a bridesmaid in the port of Petropavlovsk—arrive chiefly by sea. Outbound ships from Kamchatka carry tons of frozen salmon, bound primarily for China, Japan, and South Korea.

percent of all wild Pacific salmon go to spawn.

Although larger than California, the peninsula has less than 200 miles of paved roads. The capital is Petropavlovsk-Kamchatsky, on the southeastern coast, containing half the total population. Across a nicely protective bay sits the Rybachiy Nuclear Submarine Base, Russia's largest, in support of which the city grew during Soviet times, when the entire peninsula was a closed military region. Travel to most other parts of Kamchatka is still difficult for anyone who doesn't have access to an Mi-8 helicopter. But there is a modest network of gravel roads, and one of those winds upstream along a narrow waterway called the Bystraya River, amid the southern Central Range, to the Malki salmon hatchery, a complex of low buildings surrounded by trees.

Hatchery operations began in Kamchatka in 1914, during the twilight of the tsars, but this facility was established just three decades ago. In a lounge room off the entryway, someone hung

a poster, declaring in Russian: "Kamchatka was created by nature as if for the very reproduction of salmon." That sounds almost like a myth of origins, but the poster listed some nonmythic contributing factors: Permafrost is largely absent, rain is abundant, drainage is good and steady, and because of Kamchatka's isolation from mainland river systems, its streams are relatively depauperate of other freshwater fish, leaving *Oncorhynchus* species to face few competitors and predators. The poster was right. Judged on physical and ecological grounds, it's salmon heaven.

Unfortunately, those aren't the only factors that apply. Kamchatka's tottering post-Soviet economy, fisheries-management decisions (and the politics behind them), and how those decisions are enforced will determine the fate of Kamchatka's salmon runs, driving them toward a future that lies somewhere between two extremes. Within a relatively short time, maybe ten years or twenty, the phrase "Kamchatka



Scene-stealing Koryaksky Volcano looms above Petropavlovsk-Kamchatsky, the regional capital. Here entrepreneurs and bureaucrats execute plans for pipelines, roads, and mines—developments that will build wealth but endanger salmon runs.

salmon” could represent a byword for good resource governance and a green brand, reflecting the greatest success story in the history of fisheries management. Or that phrase could memorialize the saddest and most unnecessarily squandered conservation opportunity of the early 21st century. Think: American alligator. Or think: passenger pigeon. At present, the situation is fluid.

LIFE IS HARD ENOUGH for a salmon, even without politics and economics. Consider the 1.2 million fry released each spring from the Malki hatchery. Roughly five inches long after their first months of growth, they face no easy path from infancy to adulthood. What they face, rather, is a high likelihood of early death. For starters, the hatchery lies about a hundred miles (as a fish swims) from the sea. Each little salmon must descend the Bystraya River to its confluence with a larger river, the Bolshaya. Eluding all manner of freshwater perils on the Bolshaya,

it must gradually metamorphose into a different sort of fish, a smolt, capable of making the transition to life in salt water. From the mouth of the Bolshaya, on Kamchatka’s west coast, it must enter the bigger world of the Sea of Okhotsk, a frigid but nourishing body of water between the peninsula and mainland Russia.

Then, for a period of two to five years (depending on the species), that fish must circulate through the Sea of Okhotsk or else southeastward around the peninsula’s tip into the expanse of the Pacific. The fish might travel thousands of miles, finding its preferred food (mostly small squid and crustaceans) abundant but facing predation, competition, and other challenges of the marine environment. For instance, it might be caught in the open ocean by fishermen using enormous drift nets that trap everything in their path. If it survives these years of robust swimming and feeding, it will grow large, fat, and strong. That’s the advantage of anadromy (a sea-run life history): The ocean years allow

fast growth. Approaching sexual maturity, the fish will head homeward to spawn, using some combination of magnetic sensing and polarized light to find its way back to the Bolshaya River. From the estuary it will ascend upstream by smell, branching into the familiar Bystraya, and finally climbing through the same shallow riffles of the same smaller tributary that its parents ascended before it.

Thousands of eggs will be laid for every two adult fish that return. Unlike an Atlantic salmon or most other species of vertebrate, a Pacific salmon breeds once and then dies. Scientists call the phenomenon semelparity. For the rest of us: big-bang reproduction. After the adult has homed to its spawning stream, death follows sex as inexorably as digestion follows a meal. It's a life-history strategy, shaped by evolution over millions of years, that balances the costs of each spawning journey against the costs of reproductive effort, toward the goal of maximizing reproductive success. In plainer words: Since the likelihood of any fish surviving the whole journey not just once but twice is so slim, Pacific salmon exhaust themselves fatally—they breed themselves to death—at the first opportunity they get. Why hold back anything if you'll never have another chance?

So their lives enact a romantic but pitiless narrative. Their success rate is low, even under optimal circumstances. The miracle of salmon is that any of them manage to complete such an arduous cycle at all. And present circumstances on the Bolshaya River and its tributaries—though the wall poster at Malki didn't say so—are far from optimal.

LUDMILA SAKHAROVSKAYA, director of the Malki hatchery, is a sweet-spirited woman with blond hair and silver glasses who has worked there since the early 1980s. She trained as a biologist in Irkutsk, a warmish city in south-central Siberia, before moving east to this severe outpost in search of a better livelihood. For almost three decades she has watched—she has lived, like a doting nanny—the cycles of salmon rearing, release, and return.

PERESTROIKA, THE COLLAPSE OF
THE STATE, AND ORGIASTIC
PRIVATIZATION DISPOSSESSED THE
NATIVE PEOPLE OF LANDS, WATERS,
AND LIVING RESOURCES.

"Twenty years ago I remember lots of fish coming to this river," she told me, through a translator, on a crisp summer day, as we stood near her fish traps in a little tributary. Those traps were the end point for spawn-ready adults whose eggs and sperm would fuel the hatching and rearing operations of the hatchery. "A variety of species," Sakharovskaya said. "Now I don't see them."

The decline in the run of chinook, *Oncorhynchus tshawytscha*, has been especially severe, she said. These are deep-bodied and silvery creatures with purplish dorsal markings, largest of all salmon species, and therefore sometimes known as king salmon. Once they came in great, regal herds. Nowadays the Malki hatchery releases 850,000 chinook fry (as well as a lesser number of sockeye) annually, but not many adults return. What stops them? Two kinds of illegal harvest: overcatching (*perelov* is the Russian word) by licensed companies that have catch quotas but exceed them with impunity, and poaching by individuals or small crews, mostly for caviar, at concealed spots along the river. The poaching problem throughout Kamchatka is catastrophic in scale, totaling at least 120 million pounds of salmon annually, much of it controlled by criminal syndicates. A hatchery director can't fix that problem, Sakharovskaya noted, and the regulatory authorities evidently don't have the resources or the resolve to do it. So only the luckiest and most elusive of chinook reach their destiny here along the Bystraya. "We can almost count them on fingers," she said.

BUT THE BOLSHAYA DRAINAGE is only one of many river systems on the peninsula, and its hatchery fish aren't representative of Kamchatka

Ideal path for salmon swimming upstream to spawning grounds, the Vyvenka River loops through a floodplain free of roads and dams. Unlike their Atlantic counterparts, Pacific salmon spawn once and die. Nitrogen and other nutrients from their carcasses fertilize lush vegetation and help keep the ecosystem healthy.







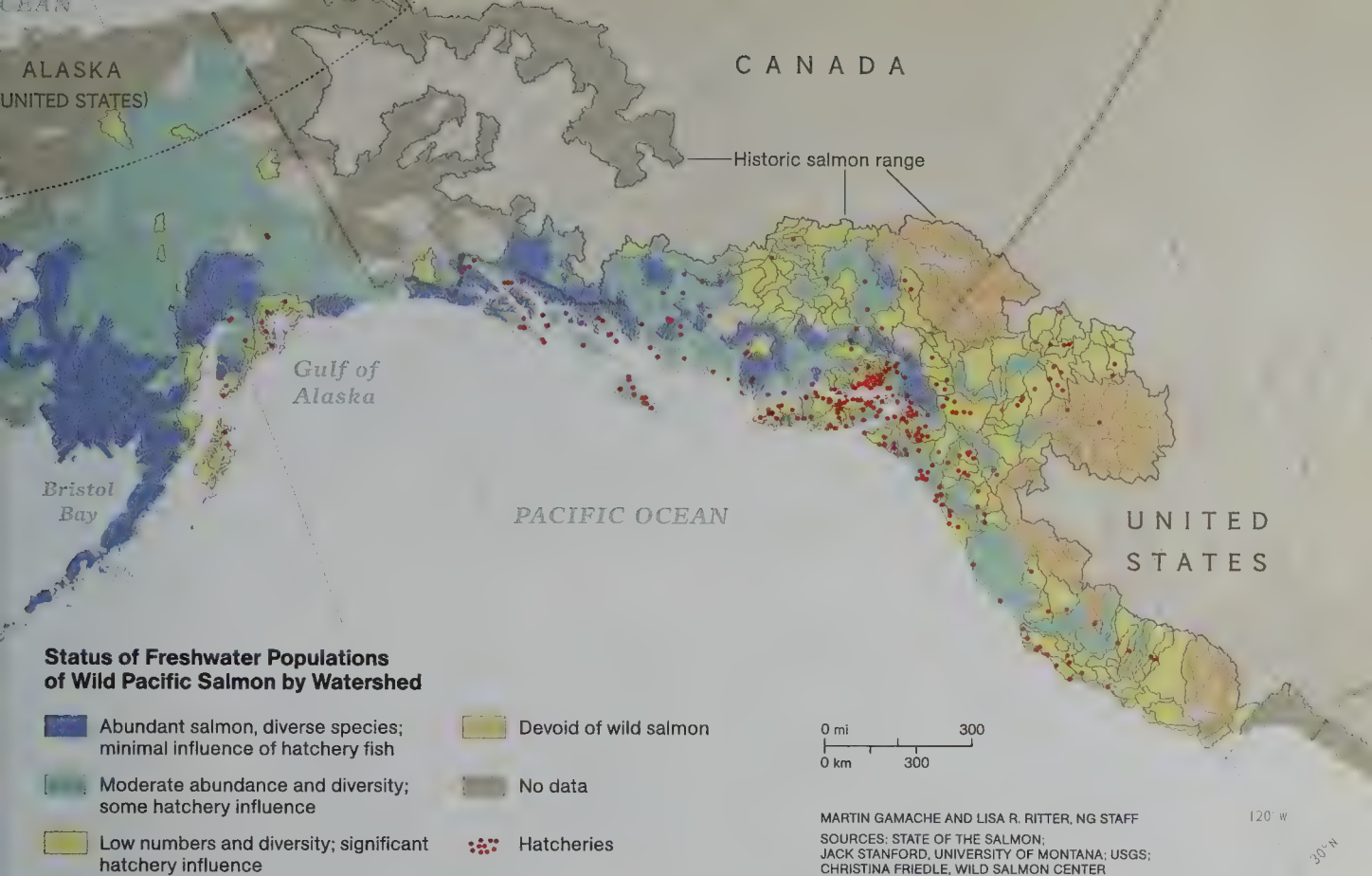
Kamchatka and Alaska offer the healthiest of the much diminished wild Pacific salmon habitats, supporting well over half the stock. With the increase in hatchery-bred salmon, the total catch has gone up, but hatchery fish compete and interbreed with wild salmon, threatening their viability.

wild salmon. Circumstances elsewhere are different; threats, opportunities, regulations, and even bureaucratic structures all change year by year. The whole situation is as complicated as a nested set of *matryoshka* dolls—Putin containing Gorbachev containing Brezhnev containing Stalin. On the Kol River, for instance, which also drains to the west coast, there is no hatchery, no streamside road, and (so far) no tragedy of depleted runs. What the Kol represents is superb habitat, scarcely touched, and abundant runs of wild salmon, including all six species: chinook, sockeye, chum, coho, pink, and masu. Last year, over seven million fish returned to spawn, filling the Kol so fully that in some stretches salmon were packed side to side like paving bricks. The Kol also carries another distinction. By a 2006 decree of the Kamchatka government, that river (along with another nearby stream) became part of the Kol-Kekhta Regional Experimental Salmon Reserve, the world's first whole-basin refuge established for the conservation of Pacific salmon.

On the north bank now sits the Kol River Biostation, a cluster of simple wooden buildings that serves as base for a binational research effort, its field operations led by Kirill Kuzishchin of Moscow State University and his American

colleague, Jack Stanford of the University of Montana. Kuzishchin, Stanford, and their team are studying the dynamics of the Kol ecosystem. They hope to address several big questions, including: How important are salmon to the health of the entire river ecosystem?

Kirill Kuzishchin is a burly man with a linebacker's neck, a sly smile, and a sharp scientific brain. He was raised on a farm near Moscow by his grandparents. At age four he caught his first fish and was evermore fascinated by things piscine; even now, as an associate professor in the ichthyology department at Moscow State, he loves to cast a line when collection of specimens is required. Among the chief lessons of his studies in freshwater ecology is that a river is more than its main channel. "The whole floodplain acts as one single organism," Kuzishchin told me during a late evening talk at the Kol station. Water flows not just downstream but from channel to channel, both on the surface and via the underground aquifer; leaves fall into the river from riparian trees and bushes, supplying food and mineral nutrients to aquatic insects and microbes; whole trees topple into the water, providing cover for fish. "Everything is connected," he said. "The faster the growth of the trees, the more of them falling



down into the river, the more habitats we have.”

But nutrients are continually lost from the upper reaches by the same gravitational pull that takes water, silt, and other material downstream. So why don’t these rivers gradually lose productivity? The reason is upstream migration by millions of salmon, Kuzishchin explained. The fish themselves bring nutrients such as nitrogen and phosphorus, accumulated during the years at sea, and surrender those precious loads to the ecosystem as their bodies decay. One aspect of the fieldwork by his and Stanford’s team is to gauge the amount of nutrients at the Kol headwaters that are delivered and redelivered by salmon.

The scientists do that by testing for a certain isotope of nitrogen, N-15, which is relatively rare compared with other forms of nitrogen but far more abundant in oceans than in rivers. High concentrations of N-15 in the Kol’s water during the season after spawning and decay, and in the leaves of the willow and cottonwood trees lining the banks, reflect the fact that salmon are bringing nutrients upstream. It’s a circular effect, Kuzishchin said. Take the salmon away (for instance, by overharvesting or by poaching), and the very leaves of the trees will be deprived of nitrogen. So will

the microbes and insects that eat the leaves. The entire ecosystem will lose nutrients, possibly to the point that it could no longer support large runs of salmon, even if they were reintroduced. He repeated his ecological maxim: “Everything is connected.”

Jack Stanford made the same point more bluntly: “If you harvest all your fish, you cannot have a productive system.”

During a fieldwork excursion upstream from the station, I saw the Kol River’s fecundity for myself. We ascended the main channel in motorized johnboats, then proceeded by foot, bashing across the jungly floodplain through a dense thicket of green plants, ten feet high but as delicate as celery, toward a side channel where the team would gather data. Kuzishchin led, chopping a corridor through the vegetation. It was mostly annual growth, consisting of thistle, nettle, cow parsnip, a white-flowered thing called Kamchatka meadowsweet, along with some grasses and ferns, together constituting a fast-growing floodplain assemblage known in Kamchatka as *shelomainik*. Finally we reached the little spring-fed channel, and as Kuzishchin and the others prepared to collect stream insects, algae, tiny fish, depth and flow readings, and willow leaves for nitrogen testing, I asked





Outnumbered and underpaid, fish inspectors in surplus tanks bog down in pursuit of poachers. Researchers say illegal harvests equal or exceed the recorded catch, imperiling stocks on many rivers.



Sergei Shurunov, head of a crack antipoaching team, muscles up with homemade weights at his camp in South Kamchatka Reserve. Aided by the WWF (World Wildlife Fund), his unit has nearly halted illegal fishing that was once rampant here.

Stanford: What allows all this herby growth to spring up here, within such a short growing season, every year?

"In a word," he said, "salmon."

THE SALMON SUPPORT a human ecosystem too. Near the mouth of the Bolshaya in a town called Ust-Bolsheretsk, a local official, Sergei Pasmurov, received me in a sparsely furnished office behind leather-padded doors. Beneath a photo of Vladimir Putin glowering down from behind a fern, Pasmurov offered a candid sketch of local history, which had been difficult recently.

Throughout the Soviet era, Ust-Bolsheretsk was a sizable agricultural center, a base for several large state farms that kept dairy cattle and grew turnips, tomatoes, and other vegetables in hothouses. Fishing was important

also, with two fish-processing plants operating here. Population stood at about 15,000 for the district, including Ukrainians, Belorussians, Irkutsk Siberians—people from all over the U.S.S.R.—as well as indigenous Kamchatkans of the Itelmen ethnic group. Then, so abruptly, so harshly, came the end of the Soviet Union, without which those government-supported agricultural collectives failed. Suddenly there was an unfamiliar phenomenon, unemployment, and the population fell markedly. Dairy production dropped; vegetables became scarce. Pasmurov described the whole cascade of changes concisely and bundled them into one freighted word—*razvalilsya*—that my translator rendered as "the ruining." Fishing became, for lack of alternatives, the major economic activity of the district.

Fishing is seasonal, also cyclical, with up-and-down fluctuations from year to year. Even during a good year the river can't support everyone. Nonetheless, about 20 different companies

David Quammen wrote about Kamchatka's wilderness in the January issue. Photojournalist Randy Olson covered the global fisheries crisis in April 2007.

or individuals are currently licensed to fish hereabouts, Pasmurov told me. The number of operators and the quota allotted to each are regulated—but not very stringently—by the Federal Agency of Fisheries. “It results in reducing fish,” he said. Year to year, the runs are becoming smaller. Poaching also plays a role. The Bolshaya is a large river, easily accessible by road, therefore hard to protect. Access will become easier still, he added, now that a pipeline is being built to carry natural gas from the west coast to Petropavlovsk, crossing the Bystraya and a dozen other rivers (including the Kol, notwithstanding its protected-area status). The pipeline itself might be clean and leakproof, Pasmurov said, but the road built alongside it will invite more poaching, especially for caviar.

And caviar—valuable, preservable, portable—is what most poachers are after. “It’s more convenient, easier to hide,” he said. “You just salt it, put it in tanks, hide it in the forest.” Later a truck, or even a helicopter, comes to collect the stash. Netting the salmon as they near their spawning streams, slitting them open, stripping out the eggs, tossing the carcasses aside as waste, a gang of poachers can do huge damage in a very short time. Their wholesale customers might even include some of the big fish-processing plants: laundering caviar for the open market.

I heard the same thing about caviar from other sources, including an ex-poacher on the Kol, who recalled that in the days before protection a small team could harvest five tons in a season. There might be 15 such teams on the river, each man making ten times the money he could in a legal fishing job. Do the arithmetic, and you find that at least 75 metric tons of illegally taken salmon eggs (each mass of eggs accounting for 20 percent of the female’s body weight) amounts to more than three-quarters of a million pounds of illegally killed fish. The carcasses of those salmon are left for bears and other scavengers—a short-term benefit to the ecosystem, yes—but every salmon thus intercepted leaves no offspring to perpetuate the run.

On the lower Bolshaya I saw the business of salmon fishing as practiced legally. It was a

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chilly July morning. A dozen men stood ready in waders, wool caps, and rubber gloves as a net was stretched far out across the river’s channel by motorboat, then swung gradually downstream and drawn closed against the same bank, trapping hundreds of sockeye and coho in a watery corral. The men began walking the net back upstream, drawing it tighter toward the shallows, herding salmon onto a gravel beach. The fish, big and silvery (not yet flushed red, as they would be if they reached their spawning grounds), flopped robustly until there was nowhere to go. The men lifted them by their tails, one by one, and tossed them into a cargo boat. When that boat was full, it departed upstream to a landing, for unloading onto a truck, and another took its place. Within half an hour, from one set of the net, the crew took what looked like at least a thousand pounds of fish.

At one point a man lifted a nice-looking fish by the tail and tossed it back into the river. It was a female, heading upstream to spawn, I was told, so they didn’t want to kill it. One fish, at least, might fulfill her reproductive potential. But whether this operation would abide by its legal quota was another issue, impossible for me to judge as a casual observer.

LONG BEFORE THE Russian residents of Kamchatka (who are immigrants and descendants of immigrants) came to depend on salmon fishing as a pillar of the economy, the Itelmen people and other indigenous Kamchatkans had developed cultural, religious, and subsistence practices centered on salmon. The Itelmen, in particular, made their settlements along the banks of rivers, mostly in the southern two-thirds of the peninsula, where they harvested



Found with 450 pounds of illegally harvested salmon roe (below), two suspected poachers (above, at right) from Sobolevo stand by as inspectors burn the caviar, worth nearly \$10,000. Jobs are scarce, so when the salmon run, “virtually every Kamchatka settlement turns into a poachers’ camp,” says a WWF report.



salmon using fish traps and weirs. They dried the pink flesh, they smoked it, they fermented fish heads in barrels. "Those fermented heads had a great deal of vitamins," one Itelmen elder told me. "They cleaned out your stomach and all the bad things in your body." The Itelmen even venerated a god, known as Khantai, whose iconic representation was half fish and half human. In autumn the people set up a tall, wooden Khantai idol facing the river, offered it oblations, then celebrated a harvest festival of thanksgiving for the fish that had come and supplication for more to follow.

A revived form of that ancient festival is held each year in Kovran, on the west coast, which now constitutes the capital of Itelmen life. Kovran villagers still fish by the traditional methods. But starting in the Soviet era, other things changed, threatening Itelmen traditions while bringing little relief to their hard lives.

Irena Kvasova, an Itelmen activist I met at a small office in a backstreet of Petropavlovsk, told me that Soviet policy had required country people, including her mother, to abandon their remote hamlets and aggregate in centers such as Kovran. There they became laborers on collective farms or fishing collectives, a very different existence for people accustomed to independence and living off the land. The Itelmen received tax exemptions, true, and the government bought the ferns and berries they gathered and the game they hunted, at fair prices.

But during the more fevered decades of Stalinism, Soviet authorities felt a need to find "enemies of the state." People anonymously denounced their neighbors, sometimes just to settle a grudge. Kvasova's own great-grandfather had been one victim. A proud Itelmen, a hunter and fisherman, leader of the collective council, he was targeted in a poison letter, arrested, and sent to the camps beyond Magadan—that is, the Kolyma River region, grimmest of all islands in the Gulag Archipelago—where he died. In the aftermath, her family stopped communicating, even with one another, so as to avoid attracting suspicion.

In the 1970s, as the Soviet regime became

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relatively less sinister but more stolidly bureaucratic, outsiders, arriving from the south, received positions and enjoyed benefits while the Itelmen people were marginalized in their own communities. Gorbachev's perestroika, followed by the collapse of the state, followed by orgiastic privatization, completed the process of dispossessing the native people of lands, waters, and living resources they had husbanded for millennia.

One sign of that progressive dispossession is that the Itelmen must compete with commercial Russian fishing companies for limited salmon-fishing quotas. The Itelmen number only about 3,500 people, one percent of Kamchatka's total. Power resides in Petropavlovsk, not in Kovran, and power influences the granting of quotas and fishing sites from river to river. The bureaucrats who grant those quotas and sites on the Kovran River have been generous to outsider-owned commercial companies, an Itelmen leader named Oleg Zaporotsky told me, while restricting the local people to quotas that are marginal, even for subsistence. The companies employ a few Itelmen, but generally not in the better-paying jobs. And beyond the issue of subsistence fishing, Zaporotsky explained, some Itelmen want to establish their own fishing-and-processing cooperatives, which would bring income to the community, support schools and other institutions, and provide good jobs that would keep people from drifting away.

Zaporotsky himself has partnered with others to buy a diesel generator for freezing fish, the first step toward claiming a market share. "If we don't create some small enterprises," he told me, "these settlements" (Continued on page 54)



How isolated is the village of Khailino? By vehicle it's a 12-hour slog to the nearest accessible town. When a supply helicopter arrives, a motorcycle rushes a few of the 700 residents, most of them indigenous Koryak people, to the nearby landing strip, where they hope to hitch a ride.





Love and Caviar



Dress-up weddings happen so seldom in Khailino, where hard times have driven out more than half the population, that when a young couple made plans to marry, the fishing community responded with a three-day bash. Residents cooked and decorated. Bride Miroslava Khalilova, seven months pregnant, pitched in with ironing (left). Her father, Rodion Khalilov (top right), supplied caviar from his fishing camp. At the gym partygoers cheered as groom Ivan Osipov went fishing for his bride's garter.





The newlyweds lead friends through the village to bring food and drink to people too old or infirm to attend the festivities. Miroslava, a nurse, and Ivan, a truck driver and a fisherman, plan to stay in Khailino, giving villagers further cause for celebration.

THE PHRASE "KAMCHATKA SALMON"
COULD REPRESENT THE GREATEST
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MANAGEMENT—OR MEMORIALIZE
A SQUANDERED OPPORTUNITY.

won't survive." So far the bureaucrats have refused to grant commercial-scale quotas to Zaporotsky's local group or any other.

ON THE OPPOSITE SIDE of the Pacific, the wild salmon runs of North America (south of Alaska), once great, have been devastated—and in some cases obliterated—by dambuilding, dewatering for irrigation, overfishing, agricultural pollution, and other forms of habitat degradation, and they've been genetically diminished by reliance on hatcheries. The people of Kamchatka have a chance to be wise and provident where Americans and Canadians have been stupid and careless. For Kamchatka to become the world's foremost wild salmon refuge, the runs in its rivers don't need to be restored; they need only to be protected from poaching, overcatching, oil and gas spills, disruptive and poisonous mining, and other forms of shortsighted mistake. The region could also become one of the richest export producers of fresh salmon, frozen salmon, and caviar. Those two prospects aren't incompatible; they're interlocked.

This is why the Wild Fishes and Biodiversity Foundation (WBBF), of Kamchatka, and its American partner, the Wild Salmon Center (WSC), supplied help and encouragement when the Kamchatka government created the Kol-Kekhta Regional Experimental Salmon Reserve, and why they support current efforts toward designating another protected area for salmon, on the Utkholok River up north. WBBF and WSC have also backed an ambitious vision of adding five more such protected areas—on the Oblukovina, Krutogorova, Kolpakova, and Opala Rivers (all draining to the west coast), and the Zhupanova River (draining

east), each to encompass not just the river itself but its full drainage basin, including the headwater streams in which the salmon spawn and all the terrestrial habitat. Those five areas, together with the Kol and the Utkholok, would make Kamchatka the planet's greatest, boldest experiment in nurturing wild salmon species for their own sakes and for the measured use of humankind. And it could actually happen—if long-term management perspectives informed by scientific research, along with honest governance backed by strict enforcement, are allowed to triumph over the scramble for short-term gain by insiders.

Of course, some people prefer the old way, whether that represents Soviet-flavored enterprises (the V. I. Lenin Fishing Collective still operates from a large building near the Petropavlovsk waterfront) or heedless private resource extraction in the spirit of Standard Oil, Anaconda (copper), and Peabody (coal). History and human need lie heavily on Kamchatka. A huge bronze statue of Lenin himself, thick-limbed and implacable, still stands in the plaza outside the main government offices. Moscow still sets the course. People without jobs still need to eat, and fish are there for the taking.

It's a long journey from idealistic plans to concrete, well-enforced protections, just as it's a long journey from the deep Pacific to the gravelly shallows of the Bystraya River. I can't forget what Ludmila Sakharovskaya said as we stood streamside at the Malki hatchery. Twenty-five years of hatching and nurturing fish, releasing them, seeing ever fewer return, had made her cynical. She was tired too, eager to take her pension and go to Irkutsk. Yes, we have reforms now, she said—or anyway, there's talk of reforms. But that's just talk, just formalities. Poaching is easy to do and hard to prevent. She knows of whole settlements, in the mountains, filled with people who could seek a legal job but don't, who live out the winter waiting for summer, when they can poach salmon.

Were things better during the Soviet era?

She considers that for a second or two, and answers carefully: "Better for fish." □



Bear eats salmon, a fundamental drama in Kamchatka's still largely intact ecosystem. So many salmon—pink, chum, sockeye (above), coho, chinook, and masu—flood the waters that typically solitary brown bears crowd together to feed at Kuril Lake (below). This lake and other watersheds are protected. Conservationists urge adding more reserves to preserve a paradise for salmon.





Fire and debris spew from Yellowstone in an artist's depiction of a supervolcanic eruption. It's unlikely the next major blast will occur in our lifetimes, but scientists have their ears to the ground.

Beneath Yellowstone Park a monstrous plume of hot rock is causing the earth to heave and tremble. Past volcanoes have erupted with a thousand times the power of Mount St. Helens. The future is anybody's guess.

When Yellowstone



Explodes

Snowmelt and rainwater, superheated hundreds of feet below the surface, blast from Sawmill Geyser in a geothermal belch as high as 20 feet. Hardened remains of old lava flows cover much of the area.





By Joel Achenbach

Photographs by Mark Thiessen

Art by Hernán Cañellas

**On August 29,
1870, a 30-year-old
Army lieutenant
named Gustavus**

Doane, part of an exploratory expedition in the Yellowstone region in the territory of Wyoming, scrambled his way to the summit of Mount Washburn above the Yellowstone River. Looking to the south, he noticed that something was missing from a stretch of the Rocky Mountains: mountains. For miles and miles, the only elevations were in the distance, forming parentheses around a huge forested basin. Doane saw only one way to explain the void. “The great basin,” he wrote, “has been formerly one vast crater of a now extinct volcano.”

The lieutenant was right: Yellowstone is a volcano, and not just any volcano. The oldest, most famous national park in the United States sits squarely atop one of the biggest volcanoes on Earth. Doane was wrong, however, in one crucial respect. Yellowstone’s volcano is not extinct. To an unsettling degree, it is very much alive.

THERE ARE VOLCANOES, and then there are supervolcanoes. The latter have no agreed-on definition—the term was popularized in a BBC documentary in 2000—but some scientists use it to describe explosions of exceptional violence and volume. The U.S. Geological Survey applies the term to any eruption ejecting more than 1,000 cubic kilometers (240 cubic miles) of



pumice and ash in a single event—more than 50 times the size of the infamous Krakatau eruption of 1883, which killed more than 36,000 people. Volcanoes form mountains; supervolcanoes erase them. Volcanoes kill plants and animals for miles around; supervolcanoes threaten whole species with extinction by changing the climate across the entire planet.

No supervolcano has erupted in recorded human history, but geologists have pieced together what an explosion must have been like. First, a plume of heat wells up from deep within the planet and melts rock just beneath the crust of the Earth, creating a vast chamber filled with a pressurized mix of magma, semisolid rock, and dissolved water vapor, carbon dioxide, and other gases. As additional magma accumulates in the chamber over thousands of years, the land above begins to dome upward by inches. Fractures open along the dome's edges, as if burglars were sawing a hole from beneath a wooden floor. When the pressure in the magma chamber is released through the fractures, the dissolved gases suddenly explode in a massive, runaway reaction. It's like "opening the Coke bottle

after you've shaken it," says Bob Christiansen, a U.S. Geological Survey scientist who pioneered research on the Yellowstone volcano in the 1960s. With the magma chamber emptied, the surface collapses. The entire domed region simply falls into the planet, as though the Earth were consuming itself. Left behind is a giant caldera, from the Spanish word for "cauldron."

The "hot spot" responsible for the Yellowstone caldera has erupted dozens of times in the past, going back some 18 million years. Since the hot spot is rooted deep in the Earth, and the tectonic plate above it is moving southwest, ghostly calderas from the more ancient explosions are strung out like a series of gigantic beads across southern Idaho and into Oregon and Nevada, the subsequent lava flows forming the eerie moonscapes of the Snake River Plain.

The last three super-eruptions have been in Yellowstone itself. The most recent, 640,000 years ago, was a thousand times the size of the Mount St. Helens eruption in 1980, which killed 57 people in Washington. But numbers do not capture the full scope of the mayhem. Scientists calculate that the pillar of ash from the Yellowstone explosion rose some 100,000 feet, leaving a layer of debris across the West all the way to the Gulf of Mexico. Pyroclastic flows—dense, lethal fogs of ash, rocks, and gas, superheated to 1,470 degrees Fahrenheit—rolled across the landscape in towering gray clouds. The clouds filled entire valleys with hundreds of feet of material so hot and heavy that it welded itself like asphalt across the once verdant landscape. And this wasn't even Yellowstone's most violent moment. An eruption 2.1 million years ago was more than twice as strong, leaving a hole in the ground the size of Rhode Island. In between, 1.3 million years ago, was a smaller but still devastating eruption.

Each time, the whole planet would have felt the effects. Gases rising high into the stratosphere would have mixed with water vapor to create a thin haze of sulfate aerosols that dimmed sunlight, potentially plunging the Earth into years of "volcanic winter." According to some researchers, the DNA of our own species

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may pay witness to such a catastrophe around 74,000 years ago, when a supervolcano called Toba erupted in Indonesia. The ensuing volcanic winter may have contributed to a period of global cooling that reduced the entire human population to a few thousand individuals—a close shave for the human race.

FOR ALL THEIR VIOLENCE, the supervolcanoes have left little behind beyond a faintly perceptible sense of absence. The Yellowstone caldera has been eroded, filled in with lava flows and ash from smaller eruptions (the most recent was 70,000 years ago) and smoothed by glaciers. Peaceful forests cover any lingering scars. The combined effect makes it almost impossible to detect, unless you've got a good eye, like Doane had, or a geologist whispering in your ear.

"You're seeing two-thirds of the entire caldera," says Bob Smith. "The size is so immense that people don't appreciate it." Smith is a University of Utah geophysicist and a prominent expert on the supervolcano at Yellowstone. We're standing atop Lake Butte, an overlook at the east end of Yellowstone Lake, one of the best places to see the caldera. But I don't see it. I can see the lake spread out for miles beneath us and a few little hills to the north—old lava domes. But I can't follow the caldera rim visually because much of it is beneath the lake and because of the sheer scale of the thing—roughly 45 miles across. Like Doane atop Mount Washburn, I see only distant mountains on the horizon on either side and between them, to the west, the "unmountains," the emptiness where the land swallowed itself in the course of a few days.

The effects of the past eruptions are nevertheless profoundly felt in the present. The lodgepole pines that dominate the park's forests are adapted to growing in nutrient-poor soils, like those in the Yellowstone caldera. So too are the whitebark pines, whose nuts sustain grizzlies and black bears.

And of course, the land to this day

is literally boiling over. The trout that riot in the rivers would not be so abundant without the warming effects of the hydrothermal springs at the bottom of frigid Yellowstone Lake. The park roils with geysers, fumaroles, mud volcanoes, and other hydrothermal activity. Half the geysers on the planet are in Yellowstone. The hydrothermal features change constantly in temperature and behavior, with new ones popping up in the forests, spewing clouds of steam visible from airplanes, exuding vapors that have been known to kill bison on the spot.

In spite of this "most violent gaseous ebullition," as one early explorer put it, the volcano beneath Yellowstone was long thought to be extinct, as Doane believed, or at least in its dying days. Indeed, after federal surveys in the late 19th century, the volcanic nature of Yellowstone received little scientific scrutiny for decades. Then in the late 1950s, a young Harvard graduate student, Francis "Joe" Boyd, became intrigued by the presence of a welded tuff—a thick layer of heated and compacted ash, which he realized was a sign of pyroclastic flows from an explosive, geologically recent eruption.

In 1965 Bob Christiansen found a second distinct welded tuff; the next year he and his colleagues identified a third. Using potassium-

argon dating, they determined that the three tuffs were the result of three distinct eruptions. Each created a giant caldera, with the most recent eruption largely burying signs of the previous two.

Then one day in 1973, Bob Smith and a colleague were doing some work on Peale Island, in the South Arm of Yellowstone Lake, when Smith noticed something odd: Some trees along the shoreline were partially submerged and dying. He had worked in the area back in 1956 and

**If the
magma
rises
quickly,
the gases
can't
escape fast
enough.
It's like
opening a
Coke bottle
after you've
shaken it.**

Sleeping Giant

Below Yellowstone, a hellish column of super-heated rock—mostly solid, some viscous, some molten—rises from hundreds of miles within the Earth. Current stirrings may be remnants of a past eruption, or early harbingers of a still far-distant cataclysm.

AREA ENLARGED

Earthquake Swarm

In just 11 days starting last December, 1,000 quakes hit an area that averages 2,000 a year.

3+ Perceptible

0-3 Imperceptible

Magnitude

Yellowstone National Park

Magma chamber

Caldera

Buoyed by an expanding magma chamber, the caldera, formed during the last major eruption, has risen as much as 2.8 inches a year over the past decade.

2500°F

Miles 0 25

CRUST

UPPER MANTLE

MONTANA

IDAHO

Snake River Plain

WYOMING

270

Plume

Beneath the caldera, a vast rocky zone of primordial heat emanates from the mantle. This plume feeds a magma chamber brimming with volcanic fuel just a few miles below the surface.

3500°F

Hot Pockets

Current seismic data and geological conditions suggest there may be smaller pockets of hot rock associated with the Yellowstone plume.

400

CRUST

YELLOWSTONE PLUME



DETAIL



What Happens the Next Time?

Scientists can anticipate the stages of a super-eruption (below). Widespread ecological devastation would follow, and consequences would be felt for years.



Magma chamber

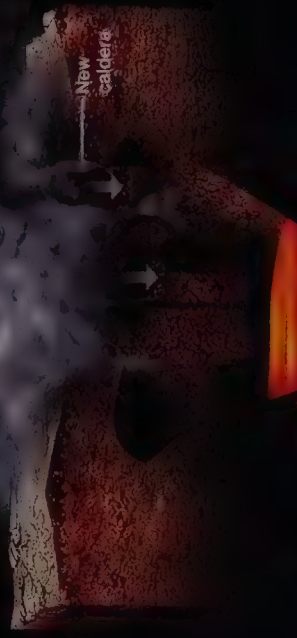
Before the Eruption

Warning signs may appear years in advance. Pressure builds from below, driving seismic activity and doming of the land over the hot spot.



The Earth Fractures

Gas-filled magma explodes upward; ash and debris soon rain down across hundreds of miles. Fiery ash flows clog rivers and carpet landscapes near and far.



New caldera

Eruptions Continue

Periodic blasts go on for weeks or even months, emitting pollutants and causing acid rain. Eventually, the land collapses and a new caldera is born.

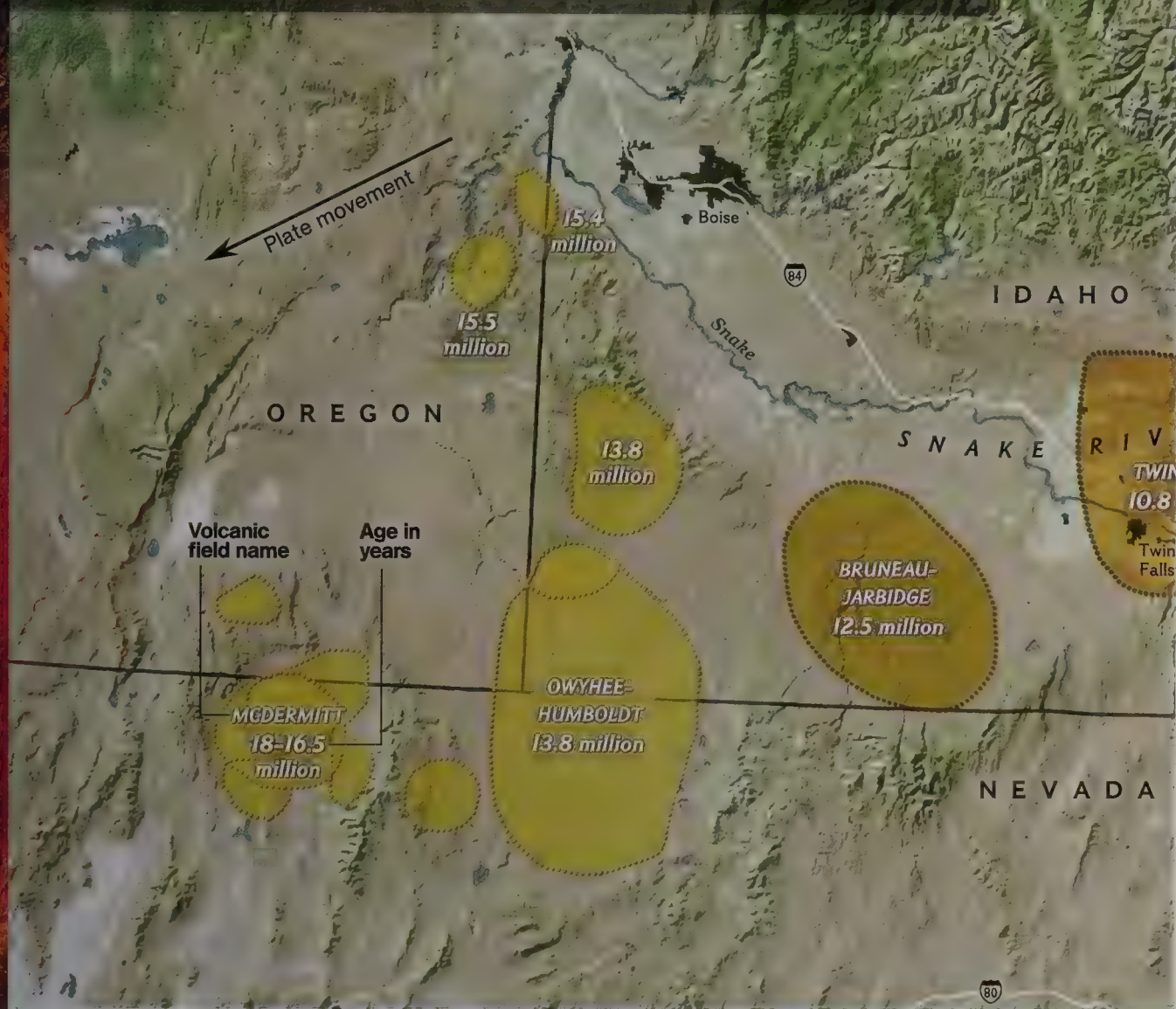
Columns of ash may rise 25 miles high, then fall.

ALEJANDRO TUMAS, NG STAFF; SHELLEY SPERRY

SOURCES: ROBERT B. SMITH, GREGORY P. WAITE, AND MICHAEL JORDAN, GEODYNAMICS OF THE YELLOWSTONE HOTSPOT PROJECT, UNIVERSITY OF UTAH; JACOB B. LOWENSTERN, USGS YELLOWSTONE VOLCANO OBSERVATORY; ROBERT L. CHRISTIANSEN, USGS (PLUME ART); STEPHEN SELF, OPEN UNIVERSITY; MILTON KEYNES, UK, (FUTURE ERUPTIONS); USGS (EARTHQUAKE SWARM)

Line of Fire

A 350-mile-long string of volcanic fields—each a site of multiple eruptions—gouges the Snake River Plain and beyond, tracing the motion of the crust across a fixed plume of superheated rock, or hot spot. Sliding southwest at about 1.8 inches a year, the North American tectonic plate has been scarred by volcanic events for millions of years (graphics, right).

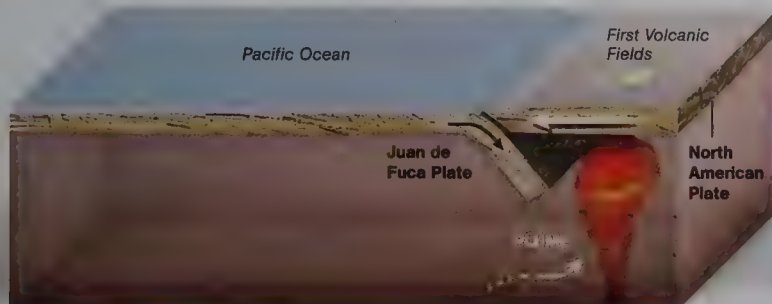


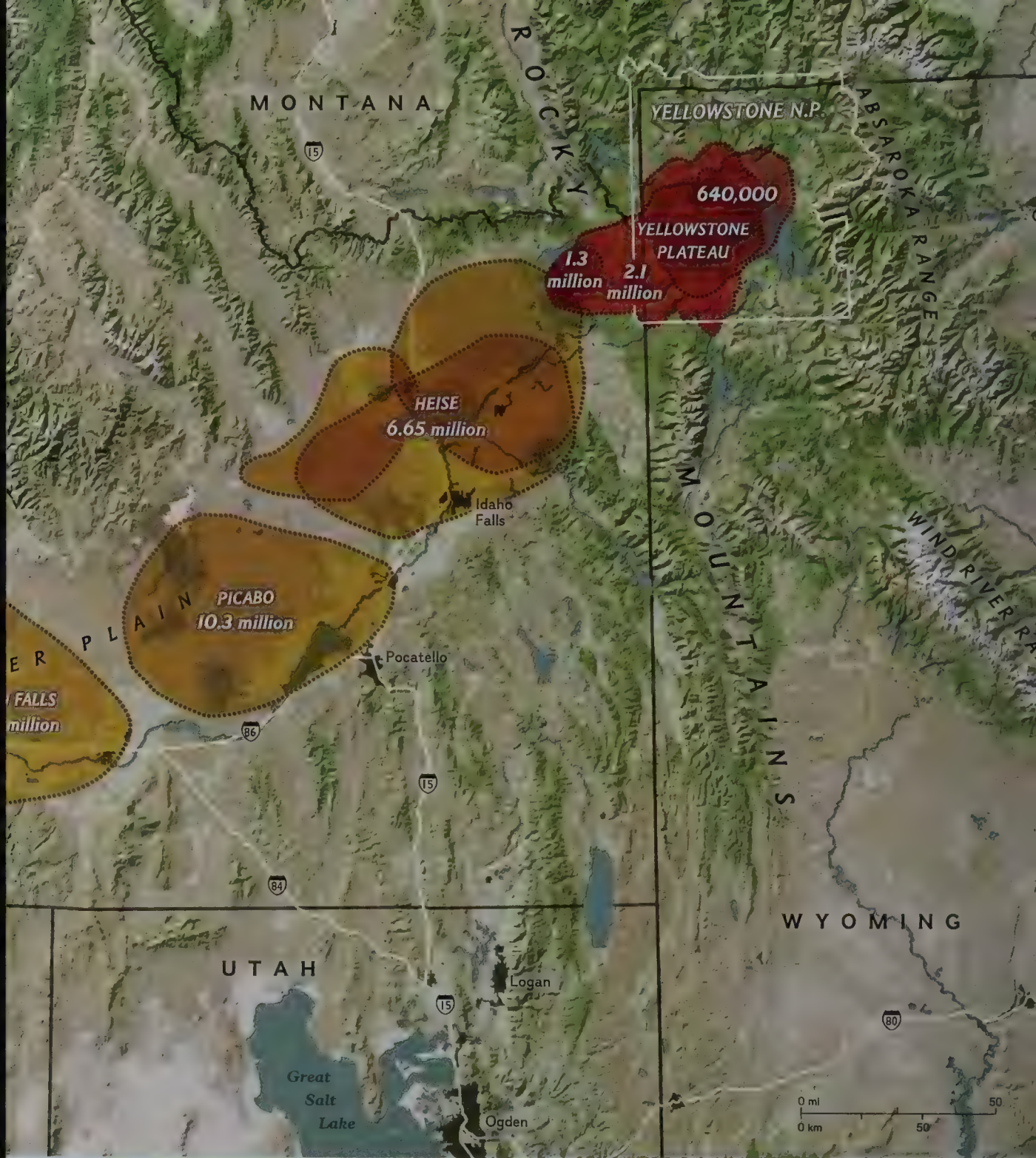
18 to 13.8 million years ago

As the edge of one tectonic plate grinds under another, the plume breaks through, causing eruptions that form vast calderas on the surface.

12.5 to 6.65 million y

Plate drift continues, with northeast of earlier site: wildlife die-offs hundred



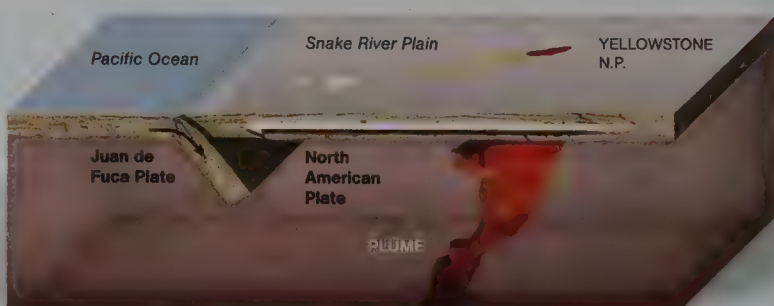
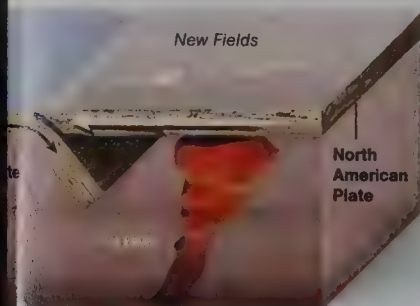


Years ago

With new blasts occurring
s. Ashfall causes massive
s of miles away.

2.1 million years ago to today

The plume drives three huge eruptions, then
settles into a calmer phase, powering Yellow-
stone's geysers, mud pots, and hot springs.



The Yellowstone Eruptions

Three major blasts, bigger than most known prehistoric eruptions, have shaken the Yellowstone National Park area in its two million years atop the plume.

How Big?

Monumental. The combined material from the three events would fill the Grand Canyon. The largest ejected enough rock, lava, and ash to bury an area the size of California under more than 20 feet of debris. Even the smallest was 280 times more voluminous than the 1980 eruption of Mount St. Helens.

Comparative Volume of Eruptions

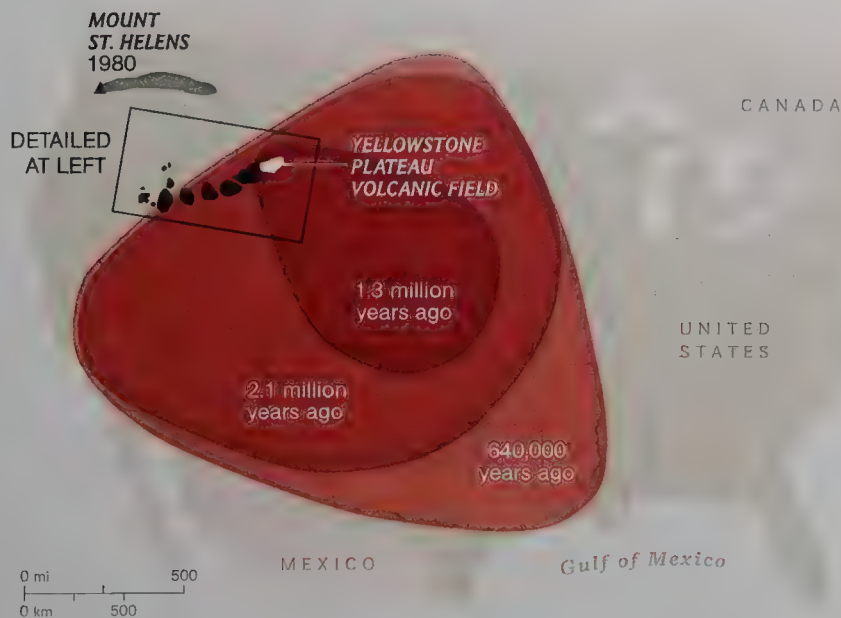
In cubic miles



How Far?

Some events spread ash thousands of miles. After the biggest eruption, wind carried dust around the globe, and ash piled up in drifts across the western half of the U.S. Near the caldera, lava and debris hardened into layers hundreds of feet thick. For years pollutants chilled the climate, devastating ecosystems.

Ash Coverage



ALEJANDRO TUMAS, NG STAFF; SHELLEY SPERRY; NGM MAPS

SOURCES: ATLAS OF YELLOWSTONE, UNIVERSITY OF OREGON AND YELLOWSTONE NATIONAL PARK (MAIN MAP); ROBERT L. CHRISTIANSEN AND KENNETH L. PIERCE, USGS

was planning to use the same boat dock as on the earlier trip. But the dock was also inundated. What was going on?

Intrigued, Smith set out to resurvey benchmarks that park workers had placed on various roads throughout the park beginning in 1923. His survey revealed that the Hayden Valley, which sits atop the caldera to the north of the lake, had risen by some 30 inches over the intervening decades. But the lower end of the lake hadn't risen at all. In effect, the north end of the lake had risen and tipped water down into the southern end. The ground was doming. The volcano was alive.

Smith published his results in 1979, referring in interviews to Yellowstone as “the living, breathing caldera.” Then in 1985, heralded by a “swarm” of mostly tiny earthquakes, the terrain subsided again. Smith modified his metaphor: Yellowstone was now the “living, breathing, shaking caldera.”

In the years since, Smith and his colleagues have used every trick they can devise to “see” beneath the park. Gradually, the proportions and potential of the subterranean volcanic system have emerged. At the shallowest level, surface water percolates several miles into the crust, is heated, and boils back up, supplying the geysers and fumaroles. About five to seven miles deep is the top of the magma chamber, a reservoir of partially melted rock roughly 30 miles wide. Basaltic magma is trapped inside the chamber by denser, overlying rhyolitic magma, which floats on top of the liquid basalt like cream on milk. By looking at the way sound waves created by earthquakes propagate through subsurface rock of varying densities, the scientists have discovered that the magma chamber

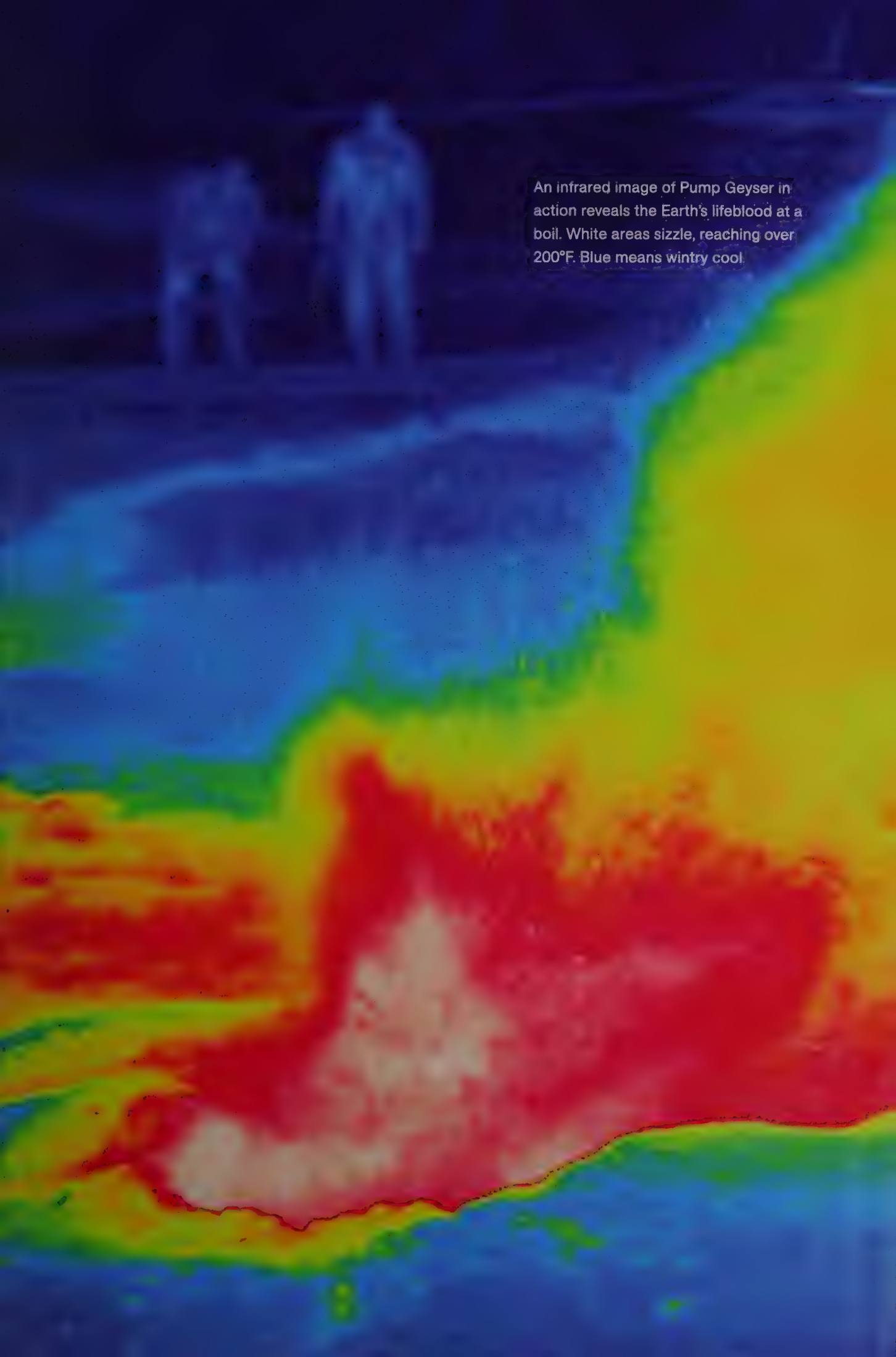
Hayden Valley, at the north end of the lake, had risen some 30 inches. The ground was doming. The volcano was alive.

is fed by a gigantic plume of hot rock, rising from the Earth's upper mantle, tilted downward to the northwest by 60 degrees, its base perhaps 400 miles below the surface. When the plume pumps more heat into the chamber, the land heaves upward. Small earthquakes allow hydrothermal fluids to escape to the surface, easing the pressure inside the chamber, which causes the ground to subside again. After the 1985 earthquake swarm, Yellowstone fell eight inches over the course of a decade or so. Then it rose again, faster this time. Since 2004, portions of the caldera have surged upward at a rate of nearly three inches a year, much faster than any uplift since close observations began in the 1970s. The surface continues to rise despite an 11-day earthquake swarm that began late in 2008, causing a flurry of apocalyptic rumors on the Internet.

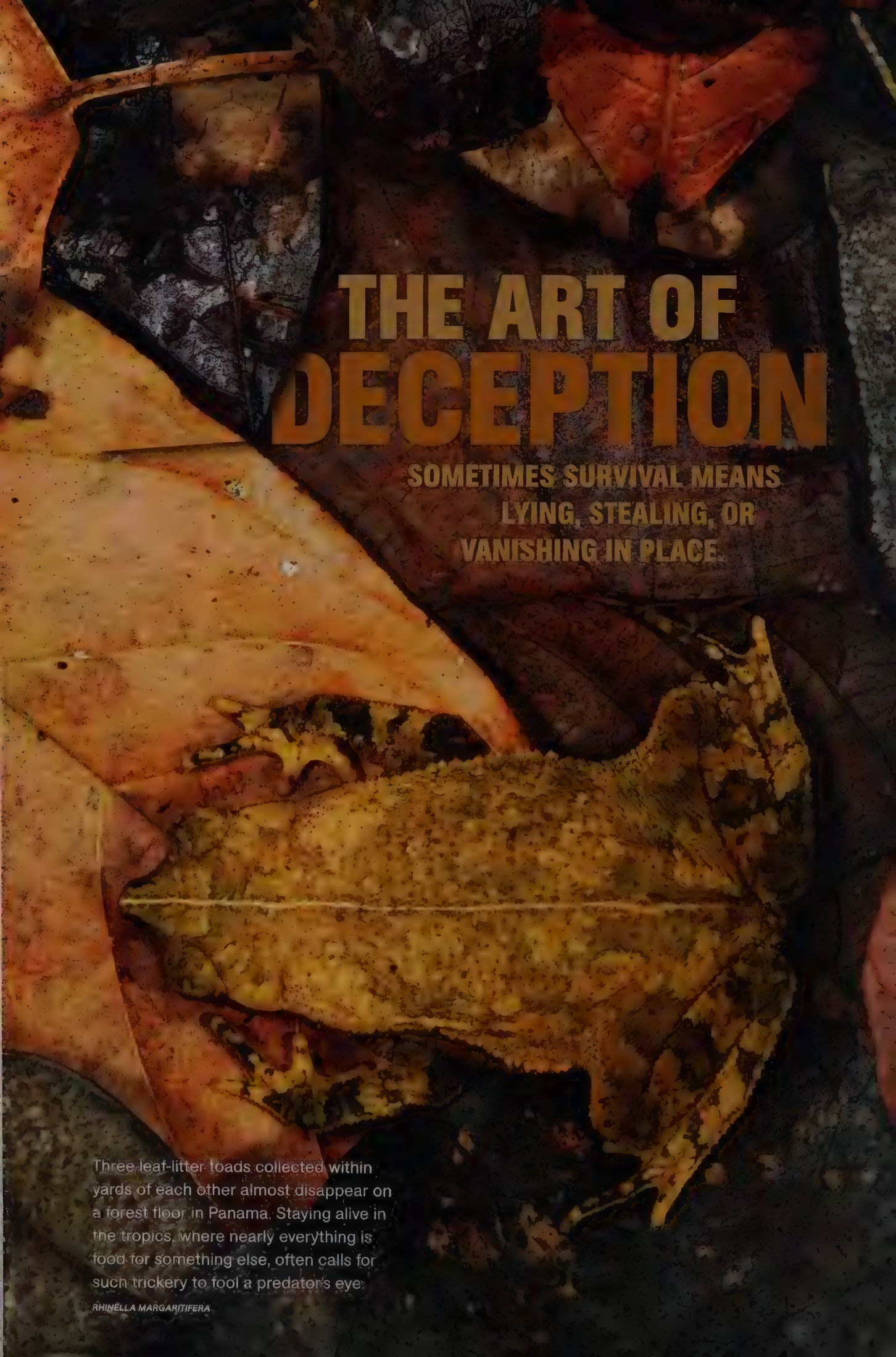
“We call this a caldera at unrest,” Smith says. “The net effect over many cycles is to finally get enough magma to erupt. And we don't know what those cycles are.”

So, the colossal question: Is it going to blow again? Some kind of eruption—perhaps a modest one like Mount Pinatubo's in the Philippines, which killed 800 people in 1991—is highly likely at some point. The odds of a full, caldera-forming eruption—a cataclysm that could kill untold thousands of people and plunge the Earth into a volcanic winter—are anyone's guess; it could happen in our lifetimes, or 100,000 years or more from now, or perhaps never. Bob Christian, now retired, suspects the supervolcano may be safely bottled up. For most of its history, the Yellowstone hot spot has formed calderas in the thin crust of the Basin and Range area of the American West. Now the hot spot is lodged beneath a much thicker crust at the crest of the Rockies.

“I think that the system has more or less equilibrated itself,” says Christian. Then he quickly adds, “But that's an interpretation that would not stand up in court.” □

An infrared thermal image of Pump Geyser in action. The image shows a large, irregularly shaped geyser vent. The central part of the vent is a bright, glowing white and yellow, indicating extremely high temperatures. This central area is surrounded by a thick, irregular ring of orange and red, representing a range of high temperatures. The outer edges of the vent and the surrounding ground are colored in shades of green and blue, indicating lower temperatures. In the upper left corner, two human figures are visible as dark silhouettes, standing on a path or platform, providing a sense of scale to the massive geyser vent. The overall image is a composite of different temperature zones, with the hottest areas in the center and the coolest areas at the periphery.

An infrared image of Pump Geyser in action reveals the Earth's lifeblood at a boil. White areas sizzle, reaching over 200°F. Blue means wintry cool.



THE ART OF DECEPTION

SOMETIMES SURVIVAL MEANS
LYING, STEALING, OR
VANISHING IN PLACE.

Three leaf-litter toads collected within yards of each other almost disappear on a forest floor in Panama. Staying alive in the tropics, where nearly everything is food for something else, often calls for such trickery to fool a predator's eye.

RHINELLA MARGARITIFERA







CREATE A DIVERSION A bird zeroing in on a flag-footed bug perched on a passionflower might see the flutter of red “flags”—the insect’s attempt to divert the hunter’s bite to nonessential limbs, away from its vital core.

ANISOCELIS FLAVOLINEATA (INSECT); *PASSIFLORA* SP. (FLOWER)

BY NATALIE ANGIER

PHOTOGRAPHS BY CHRISTIAN ZIEGLER

When Macbeth was told he had nothing to fear until the local woods started ambling up to his castle, the tyrant sighed with relief, for “who can impress the forest, bid the tree unfix his earth-bound root?”

Macbeth obviously had never been to Barro Colorado Island in Panama.

It is 9 p.m. and as dark as a witch’s mummy, but in the cone of light cast by my headlamp, parts of trees seem to be unfixing themselves and wandering at will. A four-inch twig buzzes overhead and thuds onto a nearby branch. A lime green leaf scratches through a pile of brown leaves, finds nothing of interest, and crawls toward another pile.

I approach the migrants for a closer look, knowing full well what they are but still dazzled by the details, by the almost comical earnestness of the charade they embody. The “twig” is a stick insect, a magnificent specimen of the Phasmatodea clan, its outer sheath a persuasive rendering of striated bark, its tubular body and head punctuated by fake axillary buds and leaf scars—the little knobs and notches that make a twig look twiggy.

During the day these insects move little and are nearly impossible to distinguish from the sylvan backdrop they imitate, and that, of course, is the point: to remain invisible to sharp-eyed predators that use vision to hunt. Come nightfall, however, sticks and leaf katydids shake off their vegetal torpor to do some feeding of their own—on leaves and forest-floor detritus—at which point their ancient artifice can be admired by grace of our modern artificial lights.

We are drawn to mimicry and disturbed by it too. As children, we play dress up and let’s pretend, and we understand our fellow hominins through private reenactment. Our most elaborate masquerades—for Halloween, say, or the Day of the Dead—are often tangled up with our deepest fears. What self-respecting Hollywood slasher would be seen without his Munchian mask or mother’s wig?

Mimicry in nature likewise can charm or repel us, but whatever our human judgments, this

A finger-length katydid disguised as lichen-coated bark barely registers in the dim understory of a Panama forest. But camouflage is more than just looks—the wearer must also act the part. This nocturnal insect holds stock-still during daylight hours to help conceal its contours.

ACANTHODIS CURVIDENS

much is true: Scamming works, and the natural world abounds with P. T. Barnums, which fill every phyletic niche, sucker every sense. Biologists have barely begun to tally life’s feinting legions or trace the evolutionary and genetic details of each imposter’s disguise. Sometimes the deception serves as camouflage, allowing its bearer to elude detection by predators, prey, or quite often both: In Panama I found a mantid





that looked like a few sprigs of radicchio, the perfect cloaking device for a stealth hunter of leaf-eating insects that is itself much coveted by insectivorous reptiles and birds. At other times the swindler wants its merchandise to be noticed; that's the whole point. An anglerfish wags its head until its fleshy protuberance shimmies like a worm and baits other fish. Carrion orchids sprout large, purplish, fetid blossoms that

look and smell like dead meat to attract scavenger flies, which will alight on the flowers, get dusted with pollen, and maybe, just maybe, help the orchid breed.

The sensory form that an act of mimicry

Natalie Angier is a Pulitzer Prize-winning science writer. German-born Christian Ziegler has won several international awards for nature photography.

Mimicry in nature can charm or repel us, but whatever our human judgments, this much is true: Scamming works, suckering every sense.

takes varies according to the sensory talents of the mimic's target audience. Most familiar to us visual primates are the visual mimics, the ones adapted to fool the eye, like the riparian frogs that crouch in a riverbed and look as slick and round and inorganic as the polished stones around them, or the caterpillar that, when frightened, will hold up its front end to flash a fluorescent salmon pink face with a pair of scary snake eyes. But there are vocal mimics too, like a palatable species of tiger moth that deters bats by parodying the ultrasonic clicks of a toxic moth the bats detest, or like the greater racket-tailed drongo of Sri Lanka, which mimics the calls of other birds to drum up a mixed-species flock in which the drongos can more safely and efficiently forage.

Then there are olfactory mimics, such as that mad *parfumier* the bolas spider, which can lure male moths by secreting perfect knock-offs of the counterpart females' *eaux de toilette*. There are even tactile mimics, including a parasitic fungus that lives in the inner chambers of termite mounds, where it is kept warm, moist, and competitor free. Termites are notoriously zealous housekeepers. How does the fungus elicit indulgence rather than expulsion? By assuming the shape and texture of ripe termite eggs.

Mimicry fables can sound like O. Henry stories, offbeat dilemmas dapperly resolved. For example, caterpillars are voracious eaters. They chomp their way through many leaves in their lifetimes. Birds love fattened caterpillars, and as they fly overhead, they search for signs of caterpillar activity, most notably damaged leaves. To thwart the aerial reconnaissance, one species of caterpillar has adopted a novel dining style. Rather than tearing through foliage at random, the Geometridae caterpillar cuts its leaves deftly,

mincingly, moving along the edges like a seamstress with her scissors, in and out, zig and zag. By the time the caterpillar is done, the leaves may be much smaller, but their borders maintain their maiden serrated form.

Sometimes the best offense is a ghoulish pretense. Reporting recently in the *Proceedings of the National Academy of Sciences*, Leslie Saul-Gershenz and Jocelyn Millar described the case of the abominable blister beetle and the benighted solitary bee. Blister beetles live in the southwestern deserts of the United States. Females lay their eggs in grassy patches where solitary bees forage. The beetle eggs all hatch simultaneously, and the thousand or so newborn larvae immediately gather together into a tight formation. They form a nice oval shape, all dark and fuzzy. They travel as an inseparable unit, up and down the blades of grass. They look and act just like—a female solitary bee. Before long, they start releasing a pheromone mimic, and now they smell like a female bee too. A male bee lands on what he thinks is a mate, and the blister pack clings to him en masse. Disappointed by the encounter, and seemingly unaware of his cargo, the male bee flies on in search of new love. Should he find and approach a real female bee, the beetle larvae will instantly abandon him and cling to her. The female will take them where they want to go, back to her well-provisioned nest. The larvae will deplane, settle down, and gorge themselves to maturity on nectar, pollen, and, best of all, the bee's eggs.

Of course, even the most cunning of nature's caricatures have no narrative mastermind behind them. Mimicry exemplifies evolution by natural selection, the relentless struggle in which parents spawn a diversity of offspring that chance and nature's cruel eye for weakness shear almost clean away. If your slight resemblance



Resembling flora more than fauna, a female walking leaf of Malaysia stems from a long line of extreme leaf mimics. This insect group is little changed over 47 million years, judging from a recent fossil find in Germany. The largest of thousands of leaflike species, *Phyllium giganteum* can unfurl to some four inches in length.

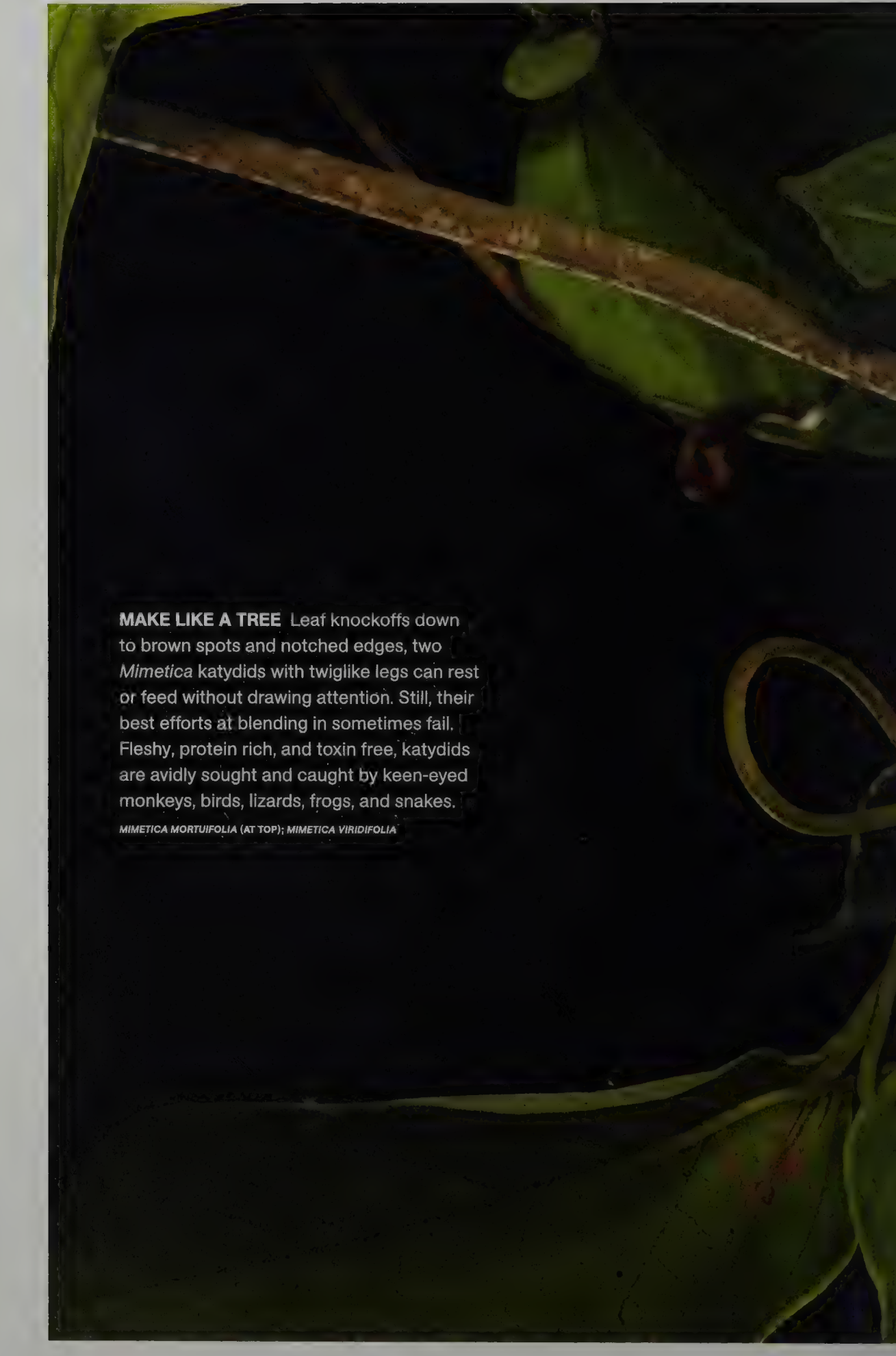
to bird dung gives you enough of an edge that you survive to breed, your progeny may inherit your lucky guano cast. Maybe one will even top you as a droppings imposter, and within a few hundred generations the trait will have spread through the whole population and be the gold standard for your kind.

Mimicry also reveals just how messy evolution can be, how ad hoc and make-do. For example, Ximena Nelson and Robert Jackson report in the *Proceedings of the Royal Society* on the dilemma of the male *Myrmarachne*, a jumping spider. Like a number of the world's jumping spiders, these arachnids have evolved to look like ants, a strategy that plays into the antipathy many predators have for the aggressive, noxiously armed, and ecologically dominant social insects. But the male spiders have a problem with the basic strategy, for mating rituals demand that they sport elongated mouthparts, which could detract from the overall antlike effect. Evolution has hammered out a compromise: Whereas the female spiders look like ordinary ants, the males with their enlarged fangs have come to resemble ants carrying bundles in their mandibles, as worker ants sometimes do. Ingenious, yes, but not perfect. It turns out that although the male jumping

spiders are as effective as their female counterparts at deterring the generally ant-phobic among hunters, the males alone fall prey to predators that target ants least likely to fight back—those encumbered with bundles.

Scientists are particularly intrigued by imperfect mimicry, where one organism only vaguely resembles another. In some cases, the crude form may indicate a lineage newly embarked on the mimicry path, when evolution has only begun to hone the simulation. In other instances, the disjunction is a result of the mimicked species pulling away from its unwanted copycats. If the warning colorations that you have evolved to advertise your hard-won unpalatability are mimicked by too many edible free riders, your brand name will be cheapened and lose its protective value.

Mimicry can also be a great way to preen, or learn, or make a new friend. Among songbirds and humpback whales, competing males seem to imitate each other's songs. And some dolphins duplicate each other's flying leaps. Parrots are masters at parroting, and ape is what the great apes do, which is why orangutans can learn to cook pancakes and chimpanzees to hunt with tools, and we compare each other to a summer's day and mirror each other's joy with a smile. □



MAKE LIKE A TREE Leaf knockoffs down to brown spots and notched edges, two *Mimetica* katydids with twiglike legs can rest or feed without drawing attention. Still, their best efforts at blending in sometimes fail. Fleshy, protein rich, and toxin free, katydids are avidly sought and caught by keen-eyed monkeys, birds, lizards, frogs, and snakes.

MIMETICA MORTUIFOLIA (AT TOP); *MIMETICA VIRIDIFOLIA*

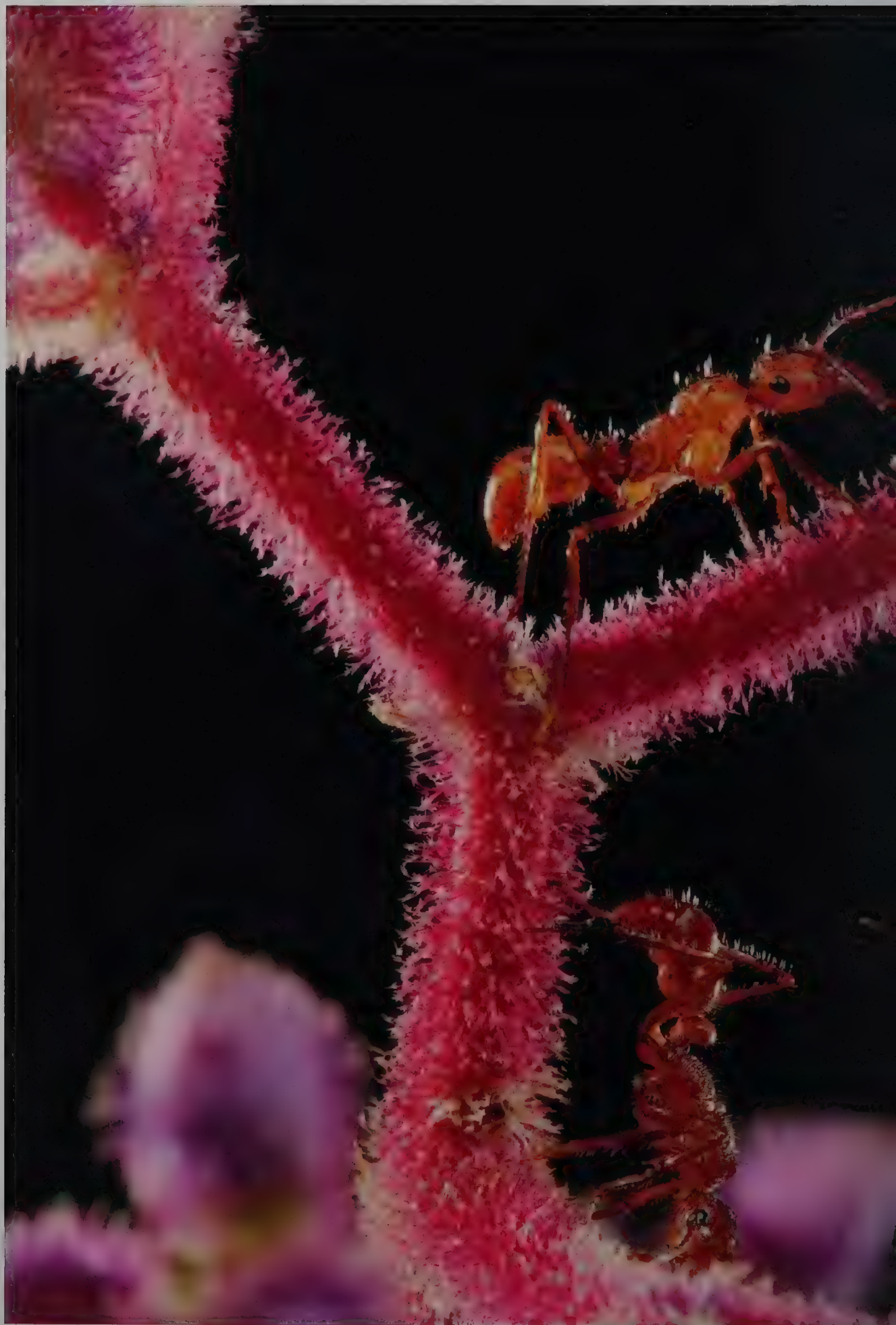




CATHEDRA SERRATA (TOP, BOTH); CEPHISE NUSPESEZ (RIGHT)

SHOW TWO FACES An extra pair of eyes, even phony ones, can be a boon to insects hunted by predators that target by sight. A saw-nosed plant hopper's first defense is camouflage (above left). But if a bird, lizard, or other hunter takes aim, the insect can startle its foe by unveiling red spots that could be mistaken for the eyes of a larger animal. A butterfly pupa (right), a species discovered in Costa Rica by Daniel Janzen of the University of Pennsylvania, also shows a false face. "Peering" from a rolled-leaf shelter, its eyespots may deter small birds exploring the foliage for insect prey. Though a prevalent ploy in nature, the fake-eye look isn't foolproof. Animals that get caught may have secondary defenses, like a foul taste or toxic secretion. The plant hopper takes a more spirited approach, buzzing like a stinging wasp to provoke a quick release.







FAKE YOUR ID Hiding in plain sight, the broad-headed *Hyalymenus* nymph (upside down) has evolved to look and act like sap-eating ants, much fiercer creatures that can sting or wield toxins, spines, and communal grit. Predators that learn to avoid the ants will also bypass the imposter. But the ploy is risky: If the ants discover the innocuous copycat among them, they'll attack.

HYALYMENUS SP. NYMPH (ANT MIMIC); *ECTATOMMA* SP. (ANTS)

CONFOUND THE ENEMY Modeling fake parts and elegant disguises, many caterpillars keep their enemies guessing. A silk moth caterpillar comes with a false head, complete with mock antennae (right), to lure predators into biting its rear. Plan B: If the ruse fails, extra spines on the real head may prompt the attacker to spit out its prey still intact.

Cryptic coloration and a shape like a leaf spine help shield a tropical Geometridae caterpillar (below), but its feeding behavior is the master stroke. By munching along a leaf's scalloped contours and keeping the edges well-balanced left to right, "it disguises the damage that could clue a predator to its whereabouts," says University of Utah biologist Phyllis Coley. For such a nondescript little inchworm, she says, "it's pretty sophisticated."



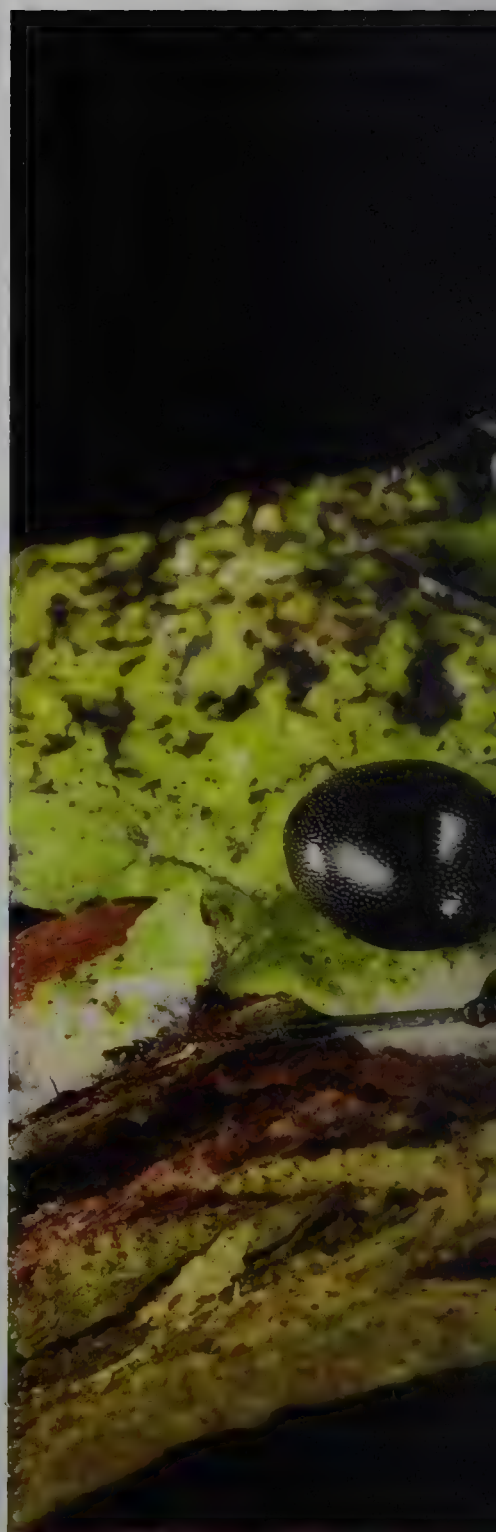
GEOMETRIDAE (LEFT); *PERIPOBA ARCAEI* (ABOVE)



GET NOTICED For one nematode parasite, the goal is not to escape, but to be eaten. When it hijacks an ant, it turns its host's back end as red and prominent as a ripe fruit (right). "This likely dupes a bird into feeding on it and getting a mouthful of nematode eggs," says ecologist Steve Yanoviak. The bird spreads the eggs via its feces, which the ants eat, continuing the cycle.

In frogs, conspicuous colors often signal toxicity. But a species on islands off Panama doesn't stick to a single color signal (below). That's counterintuitive, says Martine Maan of the University of Texas at Austin. "We'd expect the frogs to look similar so predators could easily learn to associate toxicity and coloration." But another selective force is in play. Females on different islands have developed tastes for mates of different colors, probably driving male hues to diverge instead of merge. Still, the poison alarm seems effective. Most predators likely just avoid vivid frogs, Maan says, a precautionary tactic for a perilous world.

—Captions by Jennifer S. Holland



OOPHAGA PUMILIO (LEFT); CEPHALOTES ATRATUS (ABOVE)





Vanishing Venice

The world tugs at the lovely hem of the city Thomas Mann called “half fairy tale and half tourist trap.”



For every resident Venetian, hundreds of visitors pour into the city each year to savor its gilded charms. Most will take in this view across San Marco Basin. Many could find themselves in *acqua alta*—high water.





The tide of tourism crests at Carnival, when crowds cluster around and near the Piazzetta San Marco. There are many other lovely places to linger. Mayor Massimo Cacciari advises, "Throw the map away. Get lost."





Young people gather at a neighborhood bistro. Growing tourism forces many residents to leave. But Venetian Emanuele Dal Carlo insists, "There's still time to reclaim the city. Ours is the last generation that can."

Nowhere in Italy, where calamity comes embellished with rococo gestures and embroidered in exclamation points, is there a crisis more beautifully framed than Venice. Neither land nor water, but shimmering somewhere in between, the city lifts like a mirage from a lagoon at the head of the Adriatic. For centuries it has threatened to vanish beneath the waves of the *acqua alta*, relentlessly regular flooding caused by the complicity of rising tides and sinking foundations, but that is the least of its problems.

Just ask Mayor Massimo Cacciari, broody, mercurial professor of philosophy, fluent in German, Latin, Ancient Greek; translator of Sophocles' *Antigone*; a man who raises the level of political intellect to just short of the stratosphere. Ask about the *acqua alta* and Venice sinking, and he says, "So go get boots." *Let them wear boots.*

Boots are fine for water, but useless against the flood that causes more hand-wringing than any lagoon spillover: the flood of tourism. Number of Venetian residents in 2007: 60,000. Number of visitors in 2007: 21 million.

In May 2008, for example, on a holiday weekend, 80,000 tourists descended on the city like locusts on the fields of Egypt. Public lots in Mestre, a mainland part of the municipality where people park and take the bus or train to the historic center, filled and were closed. Those who managed to get to Venice surged through the streets like schools of bluefish, snapping up pizza and gelato, leaving paper and plastic bottles in their wake.

La Serenissima ("the most serene one"), as Venice is known, is anything but. The world steps into the exquisitely carved font of the city, guidebook in hand, fantasies packed along with toothbrush and sturdy shoes. Splash! Out spill the Venetians. Tourism isn't the only reason for the accelerating exodus, but one question hovers like a haze: Who will be the last Venetian left?

"Venice is such a lovely city, said the director of a cultural foundation. From his window you could look across the San Marco Basin—with its unending flotilla of speedboats, gondolas, and water-buses called *vaporetti*—and beyond to the Piazza San Marco, epicenter of Venetian tourism. "Really, it is a huge theater. If you have the money, you can rent an apartment in a 17th-century palazzo with servants and pretend you are an aristocrat."

Please take your seats. In this play, Venice assumes a dual role. There is Venice the city where people live and Venice the city tourists visit. Lighting, sets, and costumes are so beautiful the heart aches, but the plot is full of confusion, the ending uncertain. One thing is certain: Everyone is madly in love with the title character.

"**BEAUTY IS DIFFICULT**," Mayor Cacciari said, sounding as if he were addressing a graduate seminar in aesthetics rather than answering a question about municipal policy. He quoted Ezra Pound (the American poet, buried in Venice) quoting Aubrey Beardsley's line to William Butler Yeats, a kind of literary game of telephone—but then indirection is as Venetian as the curves of the Grand Canal.

Cacciari, whose reputation for arrogance rivals his reputation for eloquence, seemed to be in a mood as black as his hair and luxuriant beard. (Not a streak of gray on his 63-year-old head. "Does he dye his hair?" I asked a press

officer. “No. He is very proud of that,” she answered.) The day before, a torrential downpour had flooded Mestre. Rain caused the flood, not acqua alta, Cacciari said, sitting in his office. “MOSE [the flood barriers under construction; see page 108] wouldn’t have helped. High tide is not a problem for me. It’s a problem for you foreigners.” End of discussion on flooding.

No, he pressed, the problems lie elsewhere. The cost of maintaining Venice: “There is not enough money from the state to cover it all—the cleaning of canals, restoration of buildings, raising of foundations. Very expensive.” The cost of living: “It’s three times as costly to live here as in Mogliano, 20 kilometers away. It’s affordable only for the rich or elderly who already own houses because they have been passed down. The young? They can’t afford it.”

Finally, there is tourism. Of that, Cacciari the philosopher said this: “Venice is not a sentimental place of honeymoon. It’s a strong, contradictory, overpowering place. It is not a city for tourists. It cannot be reduced to a postcard.”

Would you close it to tourists? I asked.

“Yes. I would close Venice—or perhaps, on reflection, a little entrance examination and a little fee.” He looked bemused.

Add the little fee to ridiculously high prices. Tourists pay \$10 to ride the vaporetto, \$13 for a soft drink at Caffè Florian, \$40 for a plastic Carnival mask, probably made in China.

Or you can buy a palazzo. “Grand Canal is prime,” said Eugenio Scola as we sat in his walnut-paneled real estate office overlooking San Marco. He wore a beautifully tailored black jacket, a crisp white cotton shirt, jeans with an alligator belt, and black loafers with the luster of polished calf. For years, buyers were Americans, British, and other Europeans, Scola explained. “But now we are seeing Russians. Also Chinese.”

Among his offerings was a three-bedroom restored apartment on the *piano nobile*, or main floor, of a small 18th-century palazzo, or palace. “*Molto bello*,” Scola said, pulling out the plans. There was a studio, library, music salon, two living rooms, a small room for the help, and a fine view from three sides. Only nine

million euros. If I preferred, there was an entire palazzo—the 60,300-square-foot Palazzo Nani, to be offered with a permit allowing its conversion to another use. “It will probably become a hotel,” Scola said. When I asked for something more affordable, I was taken the next day to see a 388-square-foot studio that would give a sardine claustrophobia, but it was only 260,000 euros. Someone would buy it as an investment or pied-à-terre. But probably not a Venetian.

IF YOU ARE A VENETIAN, and not part of what Henry James called the “battered peep-show” of tourist Venice, if you are a resident who lives in a fifth-floor walk-up apartment (elevators are rare in Venice), someone who gets up, goes to work, goes home, Venice is a different place altogether. The abnormal is normal. A flood is routine. The siren sounds, protective steel doors come down. Boots, essential to any Venetian wardrobe, are pulled on. The two and a half miles of *passerelle*—an elevated boardwalk supported on metal legs—are set up. Life goes on.

Here, where everything anyone needs to live and die must be floated in, wrestled over bridges, and muscled up stairs, time is measured by the breath of tides, and space bracketed by water. The mathematics of distance, an accounting of footsteps and boat timetables, is instinctive to every Venetian.

When Silvia Zanon goes to Campo San Provolo, where she teaches middle school, she knows it will take 23 minutes to walk there from her apartment on the Calle delle Carrozze. She leaves at 7:35 a.m. Memi, owner of a neighborhood trattoria, seated at a table reading the newspaper, looks up and nods. The young man collecting trash for the garbage barge mumbles a greeting. She turns onto the Campiello dei Morti and passes a wall draped with a white climbing rose; a bridge, two squares, another left in front of a former movie theater, now a trendy restaurant, and she proceeds on to the

Cathy Newman is an editor at large for the magazine. Jodi Cobb has worked in more than 50 countries. Her stories for the magazine include “21st-Century Slaves.”



Frezzaria. Ahead is the Correr Museum and cleaning ladies on hands and knees with buckets and brushes. She crosses the Piazza San Marco, blissfully empty in early morning. "I step on the paving stones and fall in love with the city all over again," she says. Another bridge, a brisk walk across the Campo San Filippo e Giacomo, and she arrives. It is exactly 7:58.

Listen. Venice should be heard as well as seen. At night the eye is not distracted by the radiance of gilded domes. The ear can discern the slam of wood shutters, heels tapping up and down the stone steps of bridges, the abbreviated drama of whispered conversations, waves kicked against the seawall by boats, the staccato of rain on canvas awnings, and always, always, the heavy, sad sound of bells. Most of all, the sound of Venice is the absence of the sound of cars.

Often Franco Filippi, a bookstore owner and writer, cannot sleep, and so he gets up and threads his way through the maze of streets, flashlight in hand, stopping now and then to

Luscious decay is a constant, as is maintenance. Repairing a foundation damaged by flooding means draining the canal, then clearing it of mud. To live in Venice is costly, but locals like this couple at the Casino of Venice willingly pay the price.

play a beam over facades of stucco and stone until the cylinder of light picks out a roundel of carved stone, called a *patera*, depicting some fantastic beast that slithers, prowls, or flies. It is then, while the city sleeps and he is rapt in the contemplation of a touchstone of its past, that he reclaims his Venice from the crowds that fill the streets, squares, and canals when it is day.

Gherardo Ortalli, a professor of medieval history, finds his path less poetic. "When I go out in the *campo* with my friends, I have to stop because someone is taking a photograph of us as if we are aboriginals," he says. "Perhaps one day we are. You go and see a sign on a cage. 'Feed the Venetians.' When I arrived 30 years ago, the population was 120,000. Now it is less than 60,000."



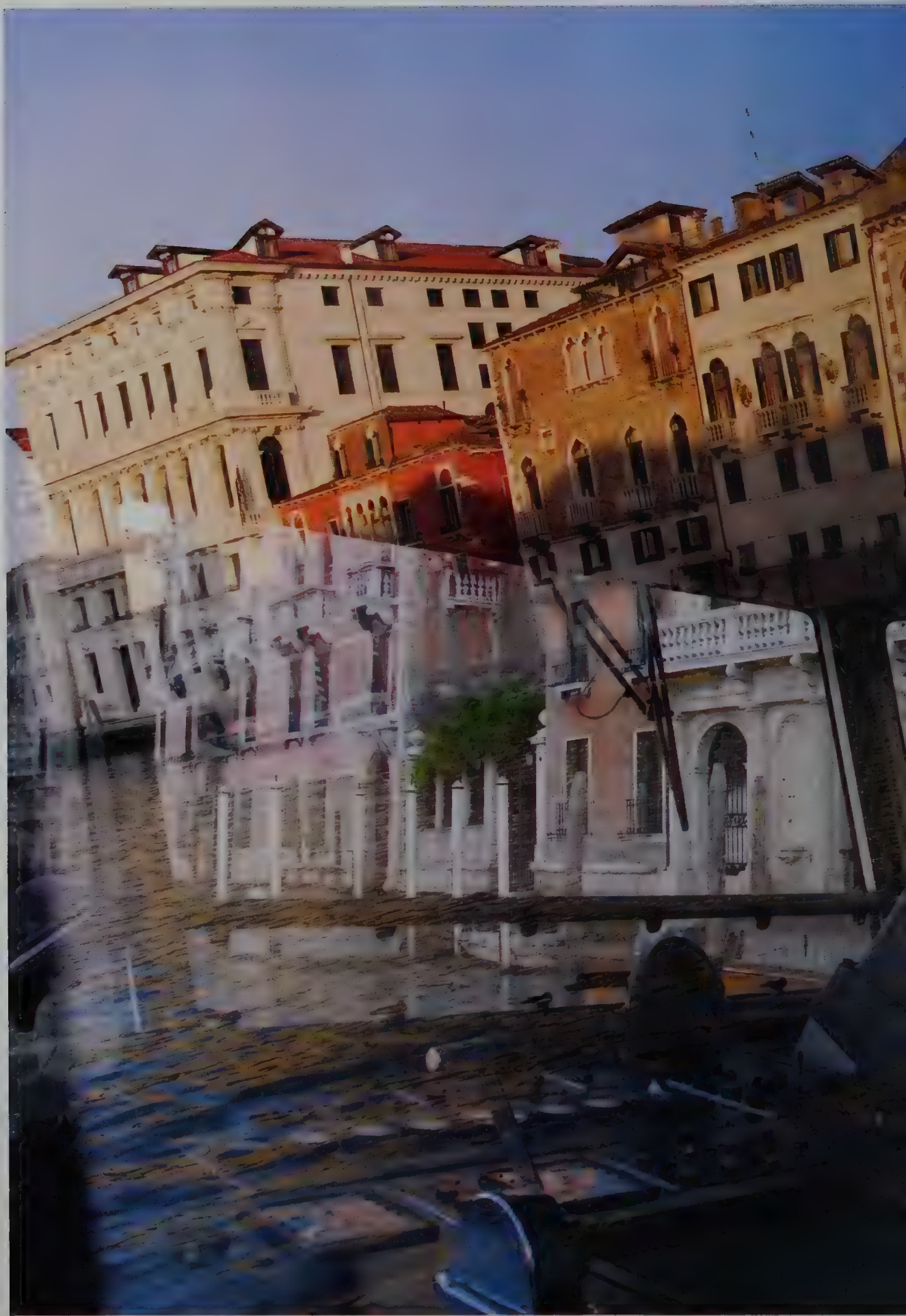
The decline seems inexorable. Last year alone, the resident population fell by 444. Ortalli thinks Venice will end up as simply a theme park for the rich, who will jet in to spend a day or two in their palazzo, then leave. It is 10 a.m., and he is headed toward a kiosk in the Campo Santa Margherita to buy a newspaper before going to his office, though you can hardly find the papers for the jetsam and flotsam of tourist kitsch: miniature masks, gondola pins, felt jester caps. "Everything is for sale," he sighs. "Even Venice."

Meet the official charged with the solemn duty of managing the wear and tear of tourism. His name is Augusto Salvadori, and his card introduces him as

*Director of Tourism
Promotion of Venice's Tradition,
History, and Culture
Protection of the Town's Propriety
and Cleanliness
Prevention of the Wear Caused by the Waves
Street Signage*

Love is not too strong a word—in fact, it is inadequate to describe how Salvadori feels about Venice. He is not just the city's director of tourism and promoter of tradition; he is its defender. If Salvadori could command it, every balcony would be draped with geraniums. (He distributed 3,000 plants with that in mind.) Once, dining at a canalside restaurant, he leaned over the table to reprimand a passing gondolier for singing "O Sole Mio," a Neapolitan, not Venetian, song.

In fall 2007 he dispatched a commando of volunteers to spread the gospel of neatness in the Piazza San Marco, to remind visitors to follow the commandments of good behavior: not to eat, drink, or sit anywhere other than in designated areas. "We are fighting for the dignity of Venice," Salvadori says. In spring 2008, he announced decorum week; 72,000 plastic bags were distributed to residents so that they could dispose of dog poop. Useful, except that no one provided extra trash cans for the used bags.





The workhorse of public transport is the vaporetto, or water-bus. It threads the Grand Canal, here reflected in the pilothouse window. The thoroughbred gondola (425 remain) is a romantic indulgence for tourists.



"The city is consumed by tourism," says Salvadori, seated in his office in the 16th-century Palazzo Contarini Mocenigo. "What do Venetians get in exchange?" A frown as his brow plummets. "Services are strained. During part of the year Venetians cannot elbow their way onto public transportation. The cost of garbage collection increases; so does the price of living." Does it ever, particularly when it comes to residential property. A 1999 law that eased regulations on the conversion of residential buildings to tourist accommodations exacerbated an ongoing housing shortage. Meanwhile, the number of hotels and guesthouses since 1999 has increased by 600 percent.

"**PERHAPS TO HELP,**" Salvadori says, "we put a city tax on hotels and restaurants. They say tourists will not come—but I say, tourists won't

come for a few euros?" He glares. "I cannot be worried about hotels. I have to think of the Venetians. My battle is for the city. Because Venice"—his voice softens, he touches his chest—"is my heart."

Tourism has been part of the Venetian landscape since the 14th century, when pilgrims stopped en route to the Holy Land. With the Reformation of the 1500s, tourism lagged, but regained momentum in the 17th century as upper-class Europeans, intent on acquiring the fine sheen of cultural experience, embarked on a "grand tour."

So, what's so different about tourism now? I ask Ortalli, after he has settled into his office. "Yes, there was the grand tour," he replies. "But then people were invested in hospitality. Now, Venice gets giant cruise ships. The ship is ten stories high. You can't understand Venice from

PLACES TO STAY Of Venice's six districts, or *sestieri*, Cannaregio has the most residents, San Marco the most tourists. A 1999 law made it easier to convert residences into hotels and guesthouses, further diminishing the housing supply for locals.



ten stories up. You might as well be in a helicopter. But it's not important. You arrive in Venice, write a postcard, and remember what a wonderful evening you had."

The malady is chronic. The onset of infection, says art historian Margaret Plant, dates to the 1880s, when the city "was fetishized, and its face was turned resolutely to the past. At that point zealously guarded Venice became a commodity city, a package of the totally picturesque. Its own citizens were confirmed as a lower order."

The contagion seeps down streets, climbs bridges, and crosses the piazza. "There goes another piece of Venice," Silvia Zanon, the teacher, said sadly when La Camiceria San Marco, a clothing store located near the Piazza San Marco for 60 years, had to move to a smaller, less prime spot because the rent had tripled. The shop, quintessentially Venetian, tailored

pajamas for the Duke of Windsor and sport shirts for Ernest Hemingway. "It's like leaving the house where you were born," said Susanna Cestari, who had worked there 32 years, packing boxes for the move.

In August 2007, Molin Giocattoli, a toy store so popular an adjacent bridge was called the Bridge of Toys, closed. Since December 2007, ten hardware stores have gone out of business. In the Rialto market, souvenir sellers have replaced vendors who sold sausages, bread, or vegetables. Tourists will not notice. They do not visit Venice to buy an eggplant.

They do, however, come to get married. The tourist machinery has incorporated weddings—720 in 2007. Predictably, nonresidents who married in Venice that year outnumbered residents by nearly three to one. Should you wish to tie the knot, the marriage office of the City of Venice will oblige for \$2,400 on weekdays. On weekends, \$5,500. Would the happy couple like the ceremony broadcast on the Internet? One hundred ninety dollars, if you please.

As for Carnival—once a charming, neighborhood event, now a commercial frenzy ("a cultural hijacking," Robert C. Davis, a professor of history at Ohio State University, wrote in *Venice, the Tourist Maze*)—sensible Venetians leave town.

One thing the Venetians haven't abandoned is their cynicism. When the exodus is complete, if the city ends up as nothing more than an exquisite, gilded bonbonnière, "Who will be the last Venetian left?" a woman whose family reached back generations was asked. "I don't know," she replied. "But certainly the last Venetian will want to be paid for it."

Meanwhile, plans for the city's salvation appear and disappear with the regularity of the tides, but the stakes couldn't be higher: Tourism in Venice generates \$2 billion a year in revenue, probably an underestimate because so much business is done off the books. It is, reports the University of Venice's International Center of Studies on the Tourist Economy, "the heart and soul of the Venetian economy—good and bad."

Some people suggest that Venice's wounds are



self-inflicted—the sequelae of the drive to wring every last euro, yen, and dollar out of tourism. “They don’t want tourists,” observes a former resident, “but they want their money. American tourists are best. They spend. Eastern Europeans bring their own food and water. Perhaps they buy a little plastic gondola.”

There is talk, always talk (this is Italy) about limiting tourists, taxing tourists, imploring them to avoid the high seasons of Easter and Carnival, but tourism—intertwined with the loss of resident population, complicated by the power of hoteliers, gondoliers, and water taxi drivers, who have an interest in maximizing the influx of visitors—defies simple solutions.

“Let me remind you, the loss of population... is not only a problem in Venice but in all historical towns, not only Italy,” cautioned Mayor Cacciari. “The so-called exodus, which dates back very far in time, is deep rooted in the lodging issue.”

Redemption may be out of reach. “It is too late,” Gherardo Ortalli, the historian, says.

There is life in Venice (440 births in 2007), but an aging population, falling birthrate, and families who leave (by barge, of course) for more affordable housing on the mainland have reduced residents from 150,000 to 60,000 in five decades.

“Nineveh is finished. Babylon is finished. Venice will remain. That is, the stones will remain. The people won’t.” But for now there is still life as well as death in Venice. Franco Filippi walks at night in search of carvings on weathered walls. Silvia Zanon leaves for school, crosses San Marco only to fall in love with the city again, and, assuming it is in season, you can still manage to buy an eggplant.

“Venice may die,” Cacciari insists. “But it will never become a museum. Never.” Perhaps. In 1852 art critic John Ruskin wrote that the Doge’s Palace would not be standing in five years. A century and a half later, it does.

To glide from the slate green waters of the lagoon past San Giorgio Maggiore to the San



Marco Basin, to approach the Doge's Palace with its tracery of arches and columns, to see it as the doges must have—enthroned on a gilded barge surging through a silver sea, oars dipping and rising, banners pulled taut by wind—is to see that beauty, difficult and bruised, survives.

As does romance. What is Venice—so seductive, so lethally attractive—except the most sublime setting for the trilling of the heart?

For example, one fall day not long ago two children, 12 and 13, from Grosseto, a town in Tuscany, decided to run away. Their parents disapproved of their romance, so they saved and spent their allowance on a train to Venice. They walked narrow streets paved in stone and lingered on the bridges that vault the canals. Night approached, and with it the need for a place to stay. They arrived at the Hotel Zecchini, a modest guesthouse with an inviting orange-and-white awning. The clerk heard a small voice ask about a room, looked up, saw nothing, leaned over the desk, and looked into the faces of two

children. Skeptical of their story about an aunt who would arrive soon, he gently questioned them, listened, then called the carabinieri.

"Such innocence and tenderness. They just wanted to be together," said Elisa Semenzato, the hotel manager. When the carabinieri arrived, they took the pair on a tour of the city in their boat, then to district headquarters in a former convent and put them to bed in very separate rooms. The next day they were served a three-course meal on a table set with linens in a hall facing the 15th-century courtyard.

Romance triumphs; reality intrudes. The parents, less than enchanted with the Romeo and Juliet narrative acted out by their children, arrived that afternoon to take them back to Grosseto, away from the soft ache of first love and the gilded beauty of Venice.

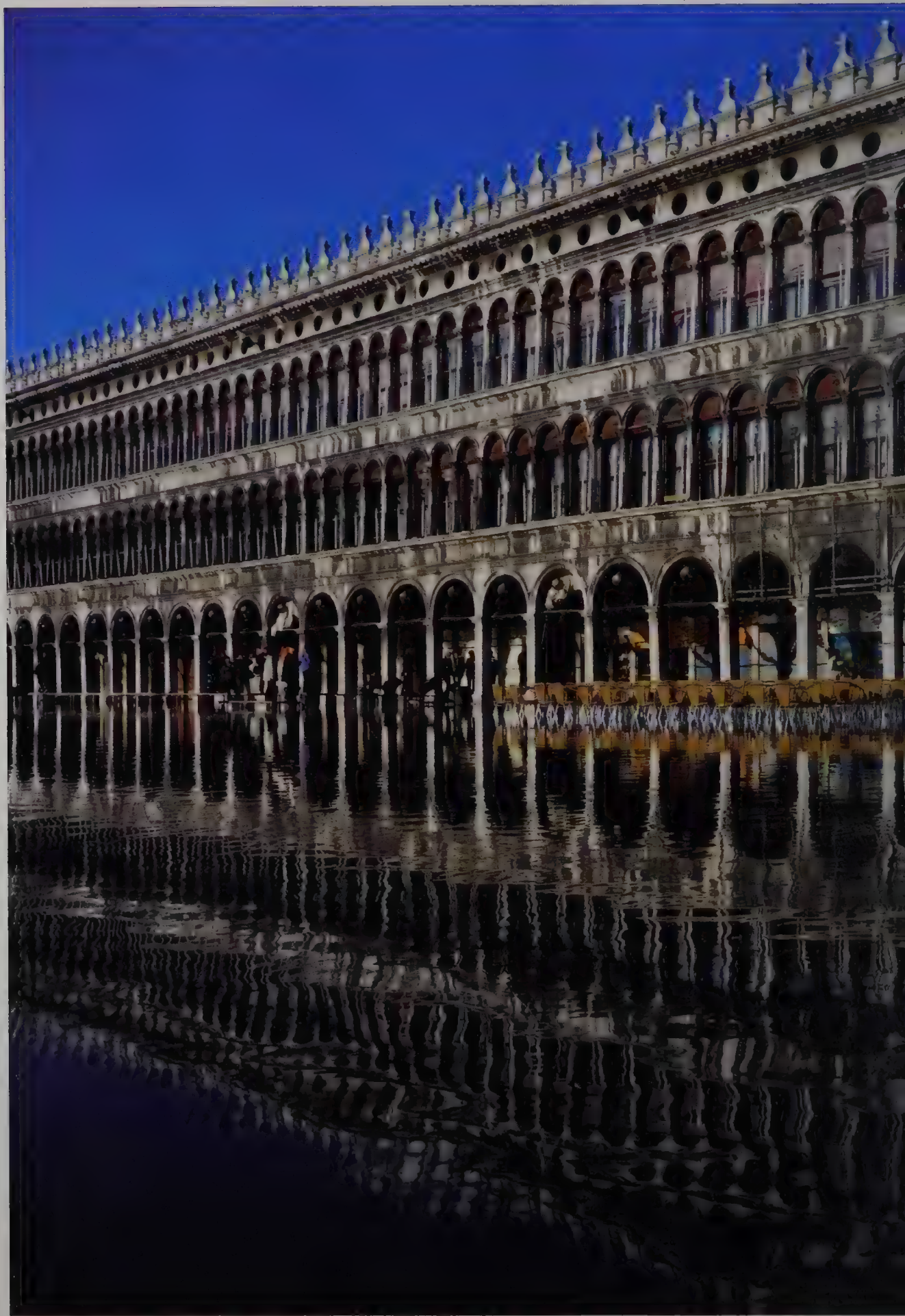
Kisses end. Dreams vanish, and sometimes cities too. We long for the perfect ending, but the curtain falls along with our hearts.

Beauty is so difficult. □



Framed in the windows of the Caffè Florian, well-heeled tourists become flamboyant extras in the opulent theatrics of Carnival, when fantasy is embellished with waterfalls of lace and voluptuous silks.







Though the acqua alta frequently floods low-lying parts of town like the Piazza San Marco, residents simply put on boots and accept it as a mild inconvenience for the privilege of living in Venice.



GRAND CANAL

SANTA CROCE

SAN POLO

DORSODURO

CANNAREGIO

Palazzo dei Camerlenghi

The ground floor
of this 16th-century
building floods
when the *acqua alta*
reaches 3.4 feet. The
stone facade shows
moderate damage.

Point of view
on overleaf

RIALTO BRIDGE

CASTELLO

GRAND
CANAL

SAN MARCO

San Marco Basin

Piazza San Marco

One of the lowest spots in
Venice, the entrance to the
Basilica in San Marco floods
frequently. Temporary elevated
walkways provide passage.

PUNTA DELLA SALUTE
TIDE-GAUGE STATION

Punta della Salute

The 1897 tide measurement here
has been the city's zero-level
reference for sea-level rise.

FLOOD ZONE

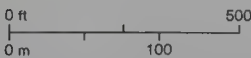
Venetians are used to getting their feet wet, and efforts to alleviate the long-term effects of water are part of daily life in the city. During the *acqua alta*, unusually high tides cause floods (map). The lowest lying areas (darkest blue) are most often inundated.



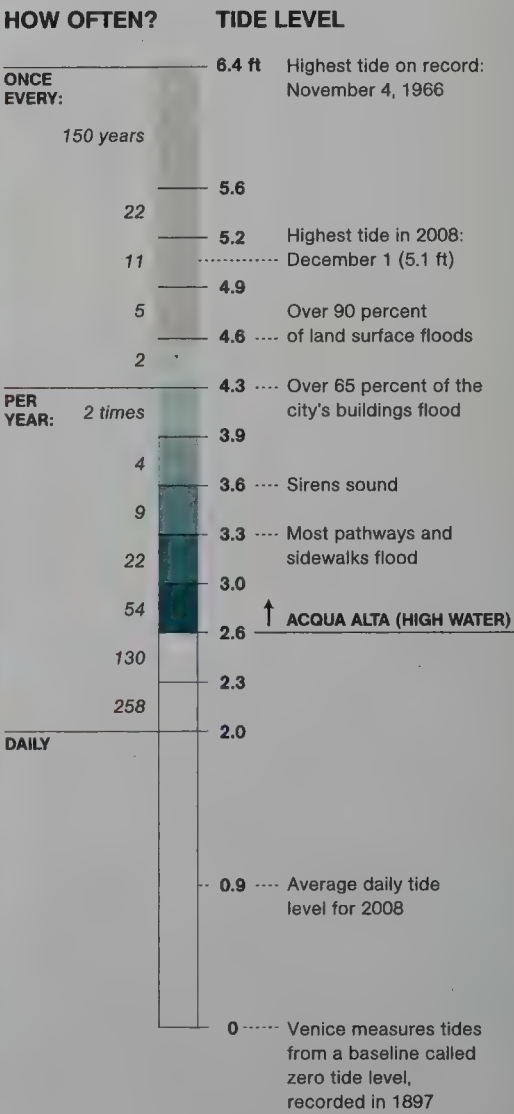
BUILDING AND CANAL-WALL DAMAGE

- Extensive or moderate
- Minimal

About half of surveyed walls and buildings show damage. Turbulent waves caused by motorboats (*moto ondoso*) can accelerate the deterioration of canal walls. When sediment accumulates in canals and clogs sewer lines, sewage seeps into adjoining canals and damages brick and mortar. Dredging sediment helps limit damage.



VIRGINIA W. MASON, NG STAFF
SOURCES: CITY OF VENICE; INSULA; FORMA URBIS; WORCESTER POLYTECHNIC INSTITUTE, VENICE PROJECT CENTER



○ Circles mark buildings most likely to flood, due to location and structure, when area is underwater.

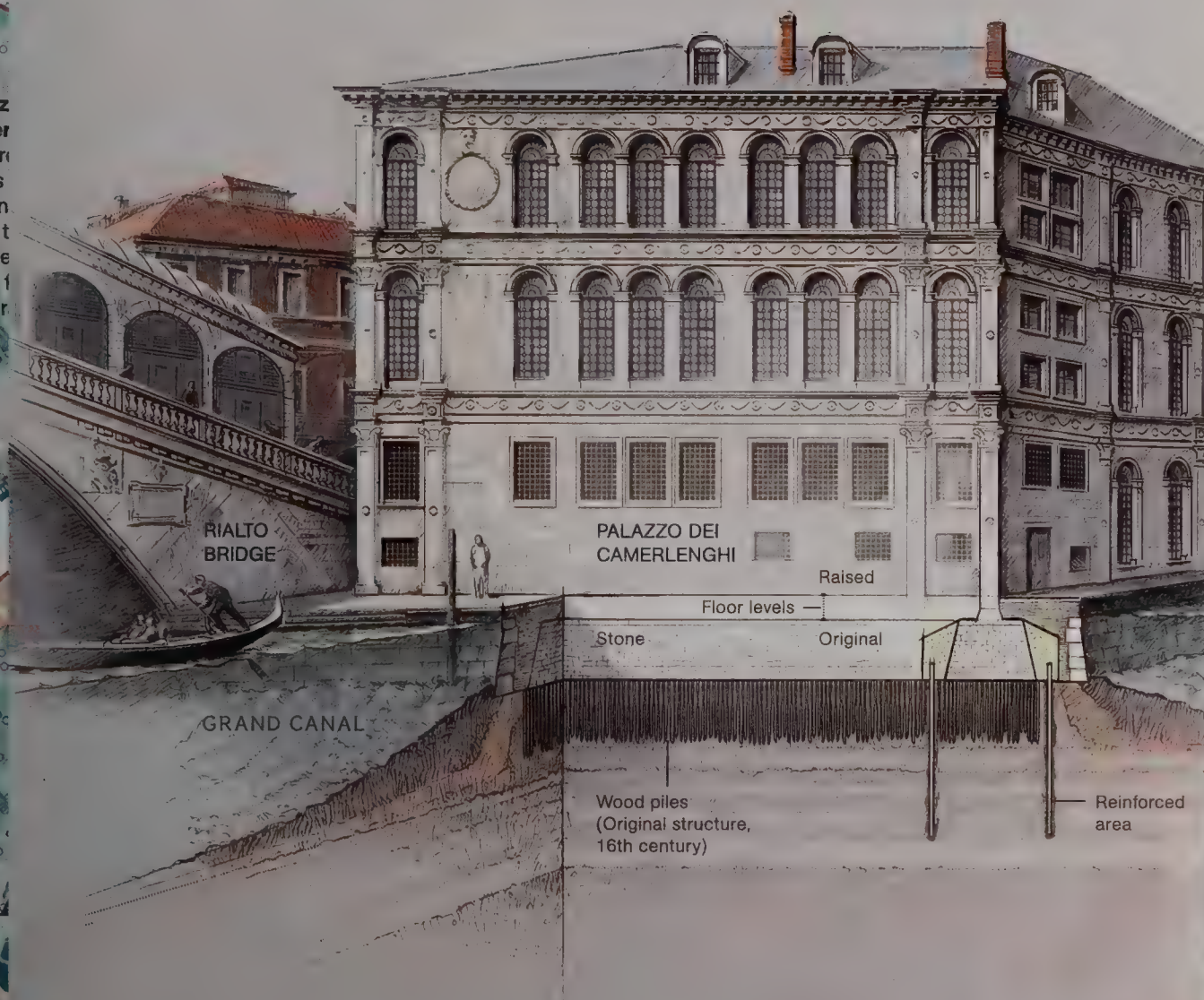


TIDE-LEVEL SCALE ROUNDED TO NEAREST TENTH.
FREQUENCIES BASED ON 1966-2008 AVERAGES.
FLOOD-INFORMATION MAP BASED ON AN INTERPOLATED MODEL OF BUILDING, SIDEWALK, AND PIAZZA ELEVATION DATA.

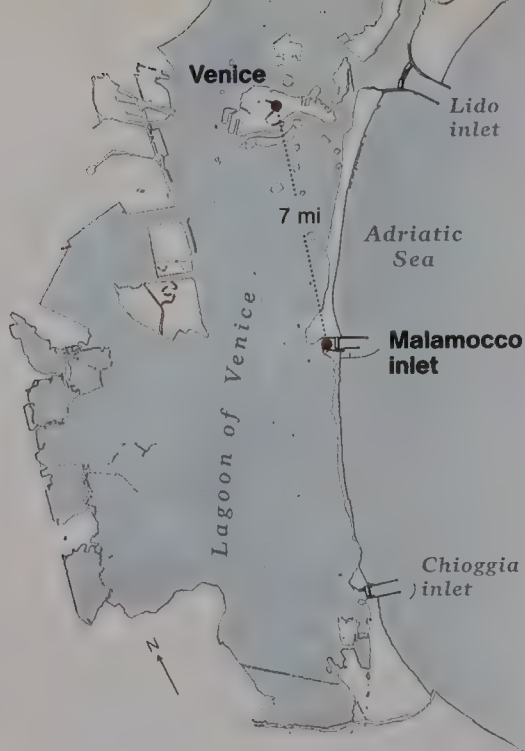
VENICE

VERSUS

THE SEA



The Venetians put down roots—on a cluster of islands in a lagoon at the north end of the Adriatic Sea—by driving alder and oak piles into the sandy ground. Atop these foundations they built homes and palaces and began a battle against the ceaseless rise and fall of the tides. The city's structures, despite reinforcements, have suffered the assault of brackish water, sea-level rise, and subsidence (sinking)—some five inches in the past century. Excessive pumping of ground-water contributed to subsidence.



MOSE: TO STEM THE TIDES

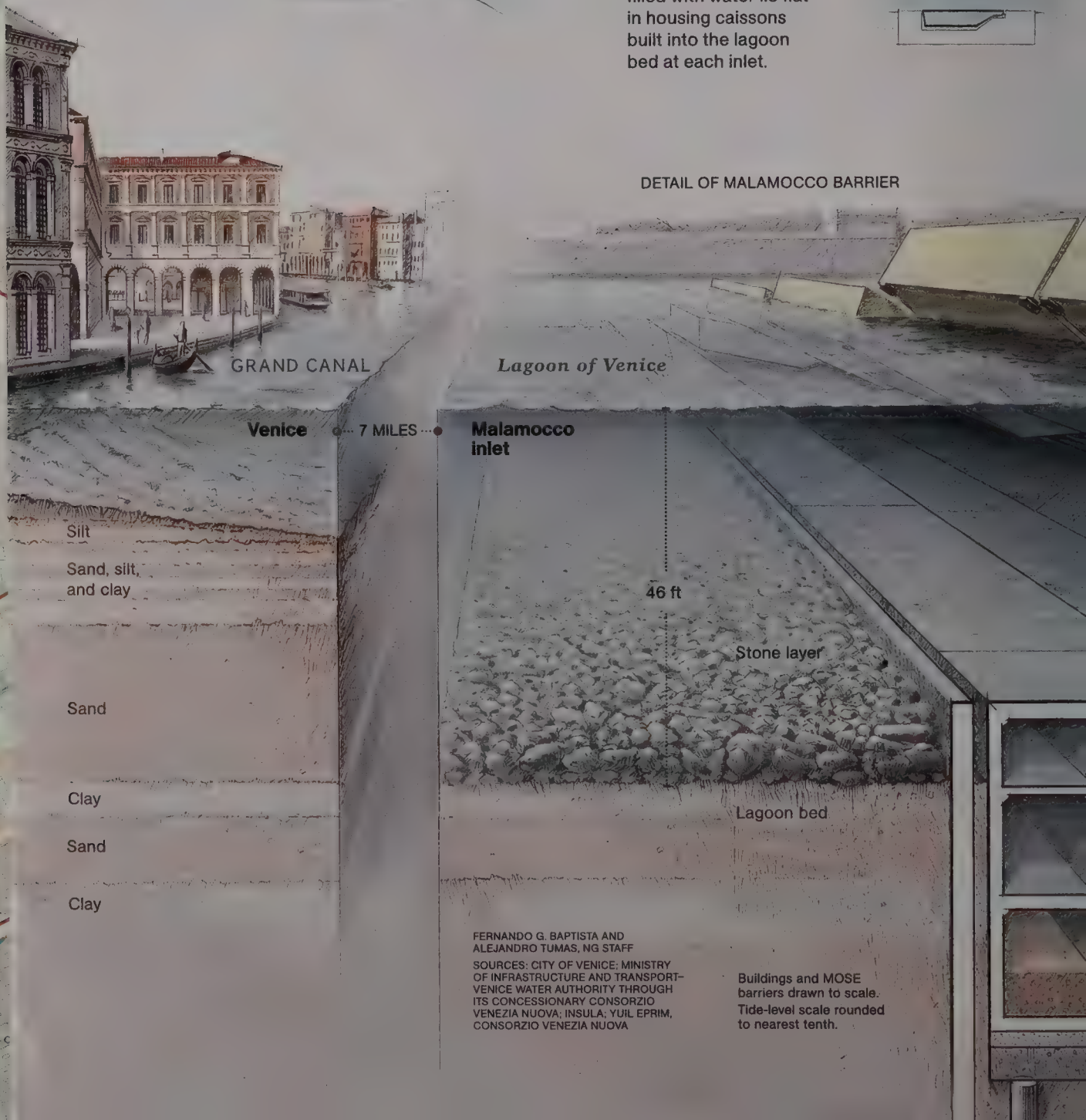
The MOSE project, begun in 2003 and projected to be complete in 2014, will string four barriers made up of 78 floodgates—at a cost of nearly six billion dollars—across the three inlets (left) to Venice's lagoon. The gates, raised when unusually high tides threaten flooding, will block seawater from pouring into the lagoon. Controversial from the start, the project provoked years of political wrangling as well as worries about lagoon ecology.

How it works

- 1 Hollow steel gates filled with water lie flat in housing caissons built into the lagoon bed at each inlet.



DETAIL OF MALAMOCCHO BARRIER

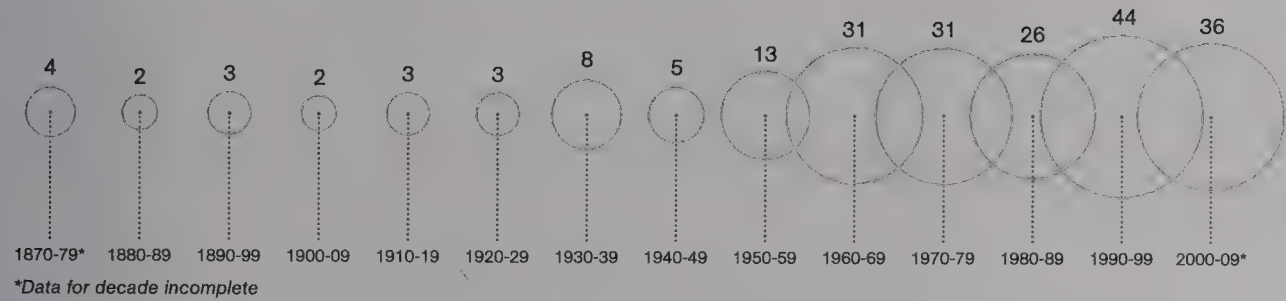


FERNANDO G. BAPTISTA AND
ALEJANDRO TUMAS, NG STAFF
SOURCES: CITY OF VENICE; MINISTRY
OF INFRASTRUCTURE AND TRANSPORT-
VENICE WATER AUTHORITY THROUGH
ITS CONCESSIONARY CONSORZIO
VENEZIA NUOVA; INSULA; YUIL EPRIM,
CONSORZIO VENEZIA NUOVA

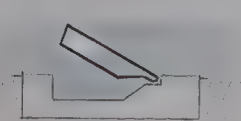
Buildings and MOSE
barriers drawn to scale.
Tide-level scale rounded to
nearest tenth.

BEYOND THE BRINK

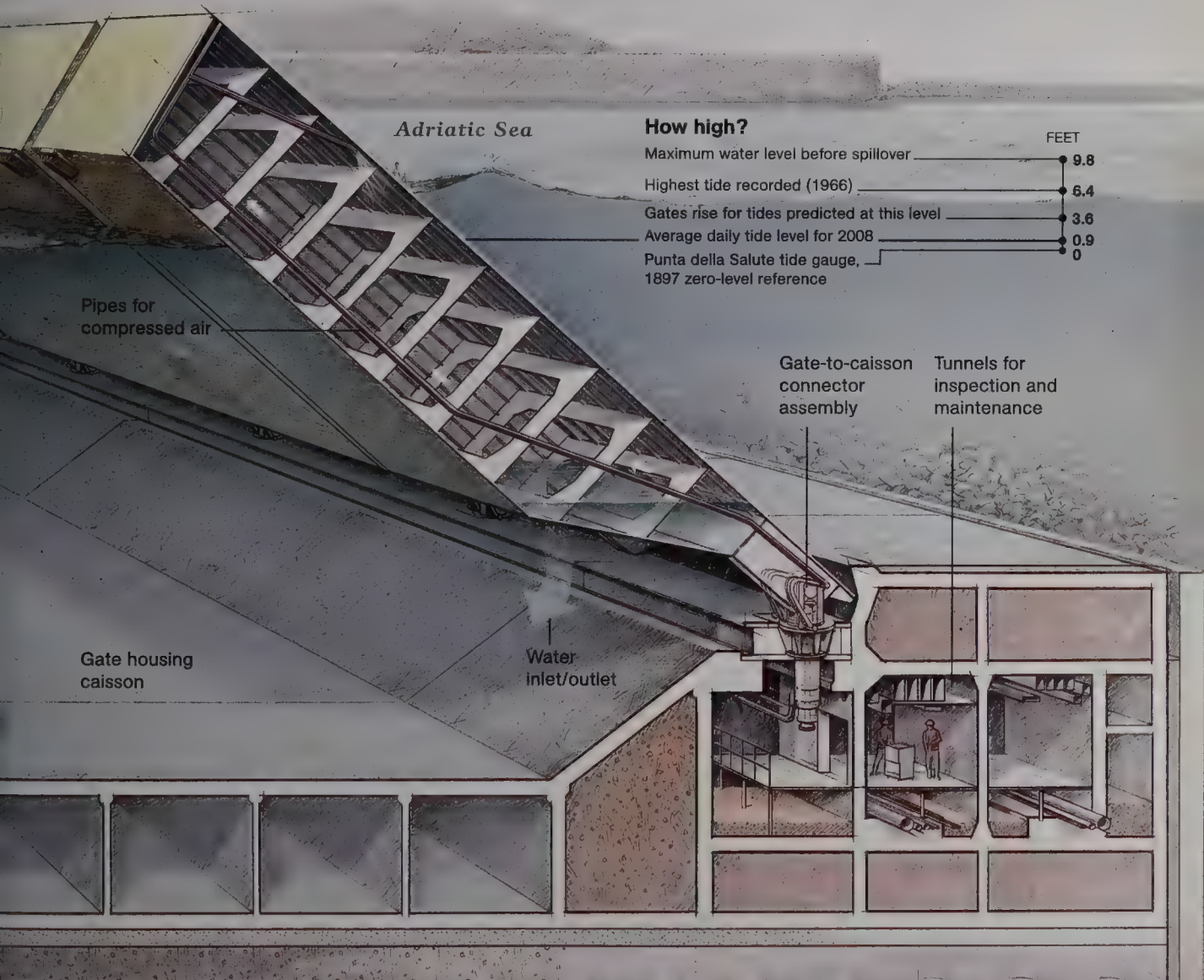
Number of times water rose to a level of 3.6 feet or higher.

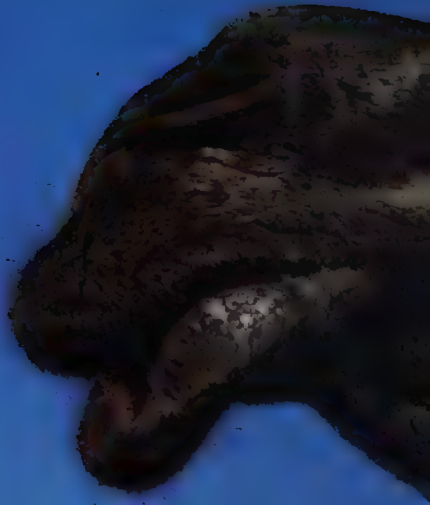


2 When a flood is predicted, air is pumped into the gates to displace water and make them buoyant, allowing them to rise within a half hour.



3 Fully elevated, the gates separate sea from lagoon. When the tide recedes, water flows back into the gates to lower them.





Isn't she lovely?

From across the vast and parched Arabian Peninsula, camels converge on Abu Dhabi for an annual beauty contest. Here the traditional beast of burden becomes a pampered show animal.







Along Million Road, a marketplace named for the huge sums camels can command, some of the contest's 24,000 entrants jostle for space with their gas-guzzling counterparts. Prizes include more than 140 cars and trucks.





Some competitors use camel calves to lure antsy mothers to the gate. Once inside the parade grounds, a turn before the judges marks the end of a long walk for many of the camels, from Oman, Qatar, and distant quarters of Saudi Arabia.



On this night—the final night—a fog swirled across the desert, as thick and impenetrable as a sandstorm. It made mysteries of the stars, and spies moved across the dunes in darkness. They searched from camp to camp in the strange air, looking for something special. ■ The quest hadn't started this way, with espionage in the dark. For a month before this January night, Bedouin caravans had trekked great distances across the Arabian Peninsula, from Oman,

Saudi Arabia, Qatar, and elsewhere. They had come to a remote spot in the Abu Dhabi emirate to take part in the show: a beauty pageant for camels.

For nine days the animals paraded before a grandstand—camels of all sorts, the most prestigious being groupings of 35 females—and imperious judges waved away the homelier groups with their dejected owners. As the days passed, the judges rewarded certain standards with dispatch, winnowing a field of some 24,000 contestants.

By the tenth day just two Bedouin men remained with their resplendent beasts. The men—who as elder heads of their families went by family names, Bin Tanaf and Rames—would face each other in a meeting fraught with intrigue and rivalry, since they were cousins from the same tribe. For years they had jostled for position and prestige at smaller contests, and the result now would decide each man's place not only in the world of camels but also within his very tribe. The winner stood to leave with extravagant prizes, yes, but more important, with family honor.

So each sent spies. Beauty spies, who scoured the camps for the one especially gorgeous camel that—once purchased—might give him an edge when the sun rose and judgment began.

Consider, for a moment, the camel. Note the great hump, the lolling mound of fat that sways with each step of the skinny legs. The knock-knees and flat feet less happy at a run than a galumph. See the neck, too, drooping as if under the weight of the head. And then the

head itself: the absurd eyelashes fluttering above oblong nostrils and rubbery lips, from which dribbles a stream of thick, white cud. This is not a creature of surpassing beauty, surely; this is a creature of spare parts.

But the judges in Abu Dhabi view camels with different eyes, scrutinizing them from nose to tail and back again, evaluating each according to strict criteria. Her ears must be firm. Her back high, her hump large and symmetrical. A rump that's not too big, with just enough room for a saddle. The hair, of course, must shine. A good head is massive. Her nose should have a strong arch in the bridge, sloping toward a bottom lip that hangs down like a bauble. A long neck appeals. As do long legs. And the judges examine the two toes of the feet, looking for what their guidelines call "toe-parting length."

Because so many beauty pageants, in the end, do come down to cleavage.

Bin Tanaf, a small man with a game leg and a tidy black beard that belies his advancing years, sat on a dune overlooking his camels and reflected on nomadic life. He grew up traveling with his family from one oasis to another in a perpetual search for pasture and water. In summer the camels could go five days without water and in winter many weeks. "With them, we survived," he said, lifting his chin toward his camels.

This relationship, this love between nomad and camel, began thousands of years ago in the heart of the Arabian Peninsula. Camels, first and foremost, provided transport across the desert. They were also mounts for raiding rival tribes, to



In the shade of an elegantly appointed tent, men gather to share fruit, drink tea and coffee, and socialize the old-fashioned way—in an atmosphere filled with incense and subtle conversation.





Bedouin traditions of hierarchy persist even in the grandstand, where spectators—princes and sheikhs in front—overlook the parade grounds and judging pens (opposite). This patch of Abu Dhabi featured little but dunes until recently, when the emirate's ruling family established a camel pageant.

claim or reclaim other camels. During the first half of Bin Tanaf's life his family's camels produced milk for drinking and hair for weaving into blankets and tents. Dung for fueling fires. Urine, even, for a hair wash, to keep lice away.

Since Bedouin life centered on movement, land held no value for them; instead, camels became the measure of a man's wealth. And so, a whole vocabulary of distinctions arose to describe them. *Asayel* are the noble red camels. *Majahim* are dark. A female baby camel is a *houraa*, a new mother a *bikr*. A male at puberty is a *fahl*, and a female is *jathaa*, unless the male has been with her recently and her udder has

begun to swell, in which case she is a *laqha*. No stage in a camel's life, no moment of growth or excitement, escaped attention. The two species, man and camel, suffered and exulted as one.

Then, Bin Tanaf said, something changed. After thousands of years of sameness, life altered in radical ways. The British left in 1971, ceding control of an oil gush that rained down on the Bedouin. The tribal emirs banded together to form the United Arab Emirates with Abu Dhabi as their capital, and money—a great rolling wave of money—flooded the desert.

Bin Tanaf entered the automobile business. Oil-rich residents bought cars at a furious clip, and he shipped them from overseas makers to the emirates, Saudi Arabia, Kuwait. His compatriots made their fortunes in construction or shipping or in oil itself. They had grown up not just poor but with no conception of poor, and now the morning sun could hardly climb over their mountains of money. Unable themselves to read or write, they sent their sons to study English in London and French in Paris. They



migrated one last time, from camel-hair tents to glass skyscrapers in Abu Dhabi and Dubai.

Throughout much of the peninsula the nomad came to embody two conflicting ideas. At first city dwellers—themselves hardly removed from the desert—regarded the occasional sand-dusted Bedouin visitor as a rural curiosity, a bumpkin who carried his possessions in a sack. But that image is now giving way to something more romantic: the nomad as the quintessential Arab, a symbol of freedom. The Arab who gives no thought to oil, but merely to food and water for his camels as he rides into the sunset.

Rube or hero, he unavoidably resembles the American cowboy. And just as well-to-do Americans breed, race, and show their horses, so do Bedouin with their camels. The Arabian gentleman, like the American, spends his weekends at his stables. He examines his animals,

feeds them special food, showers them with affection. He barks at them, then sings a song of forgiveness. He loves them.

And he prepares, all the time, for fierce competition.

The contest arena itself embodied the nomadic lifestyle, taken to its most luxurious degree. The Bedouin erected a multistory grandstand, banked with plush chairs and lined with big-screen televisions that featured live footage of the contest below, all in a tent. Serving boys ran about with tea and tins of burning incense that the men waved into the folds of their *ghutras*, or head-dresses. Outside, the helipad awaited the arrival of sheikhs and princes. The women spent each day shopping at a nearby suq, a market the size of a small town, built especially for the event.

Bedouin camps dotted the landscape around the site, and with each dawn, participants would walk their camels to the arena. Row upon row of luxury sport-utility vehicles—more than 140 Range Rovers, Nissans, Toyotas, all prizes for

Matthew Teague regrets that he has yet to ride a camel. Randy Olson has photographed numerous camels, but none as cosseted as these.

various winners—framed the staging area. The judges awarded secondary prizes to single camels, to very young camels, even to male camels.

On the climactic day of the greatest contest—the caravan-size parade of females—Bin Tanaf and his cousin Rames looked over their camels. Their spies had chosen well in the night. By sunrise Rames had secretly spent two million dollars on several remarkably fetching camels. Bin Tanaf had spent more than a million on just one. Now the men moved unhurriedly, even as the sun rose into the sky. Their culture, rooted in the nomad's need for perpetual motion, values the relative luxury of stillness and calm. To be waited upon indicates rank and status. So each man wanted to show up last at the arena, to make his appearance with a peacock-like display of poky grandeur.

One of the contest organizers arrived at Rames's camp to nudge him into action. "Rames, I worry that the judges will close the gate."

Rames gazed about serenely. He carries himself with the stature of a king. "Do not worry," he said. "They will not close the gate."

Some distance away Bin Tanaf paced among his camels, awaiting word that Rames had left his stables. Bin Tanaf is the sheikh of his tribe, which gives him a position of authority, even over Rames. But in recent years Rames had cultivated a friendship with Crown Prince Mohammed bin Zayed Al Nahyan—who, as it happened, was the festival's patron—giving Rames an advantage, perhaps, in affairs of both camel and family.

Bin Tanaf waited. Then his cousin started moving toward the arena. Bin Tanaf signaled for his camels to move as well. Gradually he drew near the arena, and—horror! The upstart Rames had draped his camels in blinding silver capes, like a whole company of opera singers heaving in from stage left. Rames had spent \$20,000 a month on special camel food, and it showed. At the gate his caretakers whipped off the camels' capes to display their enchanting necks and undeniably symmetrical humps.

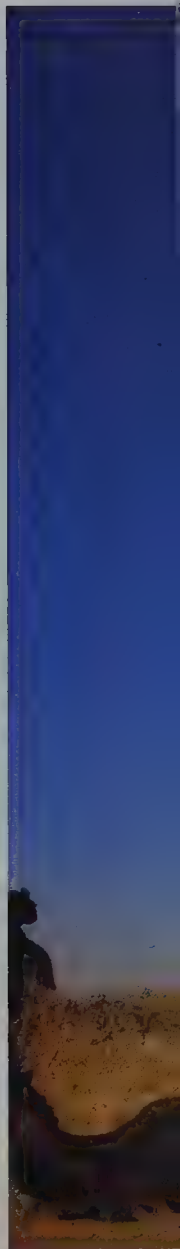
The two groups of animals paraded before the crowd. Then the two men took seats of honor in the grandstands to await the judges' decision.

A contestant protests as it is hoisted aloft for a massage to limber it up for competition. After the pageant most of the camels revert to their workaday role, trekking along ancient routes on the long journey home.

Singers gathered, and loudspeakers blasted their voices into the tent. Helicopters circled overhead, tilted on their sides so this or that royal family member could see the proceedings. Meanwhile, the cousins sat with matching nervous smiles, as though affected by some shared rictus.

At last the announcement: Bin Tanaf.

In a fit of exuberance the men of Bin Tanaf's family flung their headdresses into the air, shouted praises, and lifted their beaming sheikh onto their shoulders. Still unsatisfied, they climbed onto a marble table and lifted him higher; the whole pile came down when the table broke, projecting oranges, grapes, and men off the front of the grandstand. They regrouped on the ground below and danced a wild dance, swinging their camel crops overhead.





In one sense Bin Tanaf's reward could easily be described in modern terms: an enormous long-haul truck, some cash, a trophy. But his true victory—a victory of maneuvers, and passion, and spies in the dark—spoke of something older and greater by far.

The celebration back at Bin Tanaf's camp lasted all night. Two hundred Bedouin men sang, recited poetry, and told camel tales. Another group bashed their Land Cruisers into moonlit sand dunes at high speeds, spraying sand over a group of laughing children. Bin Tanaf and his eldest son, Mohamed, sat on the floor of an open tent, talking with friends around a communal platter heaped with rice and meat. The father's face burned with joy. "This is the best

day of my life," he said. After a few minutes two men approached carrying another platter, this one bearing a distinctive yellowish hillock. "Ah," the son said. "The hump."

That's the other thing camels provided during those long centuries in the desert. The much admired hump provided sustenance for the camel first, then later for its rider. So the camel's beauty is a practical one: A well-formed hump means nourishment. The slit-like nostrils can close tight against blown sand. Its spindly legs hold it aloft from the heat of the desert floor.

The camel's wide, flat foot, with its two spread toes, may seem strange to outsiders. But the Bedouin see only heart-shaped footprints leading over the dunes of Arabia, and across the shifting sands of time. □



Alejandro Tumas (left) and Hernán Cañellas plumb the depths of Yellowstone.

ON ASSIGNMENT Under Yellowstone One of the biggest volcanoes on Earth lurks beneath America's oldest national park. Yet no one's ever modeled it—until now. Senior Graphics Editor Alejandro Tumas and freelancer Hernán Cañellas (above) illustrated the supervolcano's depths. "If this were to explode, it would be the end of the world," says Tumas. "The possibility of that happening anytime soon is remote—a giant asteroid striking Earth is more likely. But we do know it will erupt. It's a question of *when*, not *if*."



Villagers bear the body of a slain gorilla in Brent Stirton's prizewinning photo.

Top Honors For the second year in a row, *National Geographic* took the top prize for photojournalism (below) at the American Society of Magazine Editors' National Magazine Awards. Honors went to photographer Brent Stirton's coverage of killings and the charcoal trade in the Democratic Republic of the Congo for "Who Murdered the Virunga Gorillas?" which appeared in the July 2008 issue of the magazine.





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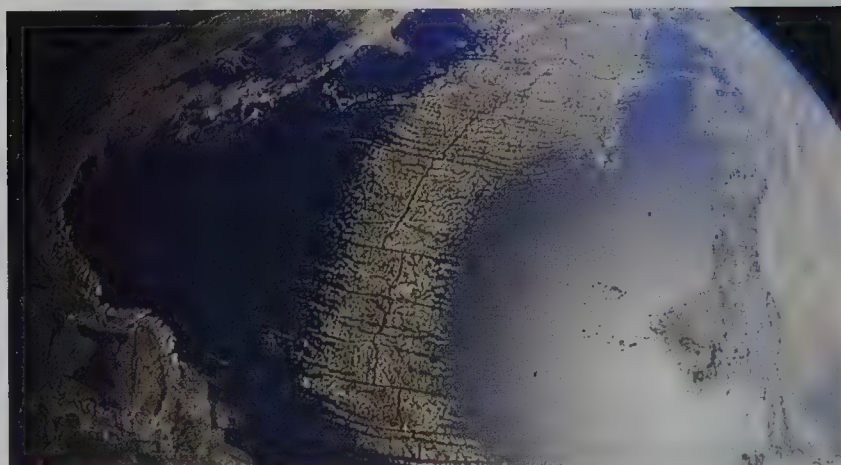
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In the Mid-Atlantic Ridge (center), landscapes are still forming.

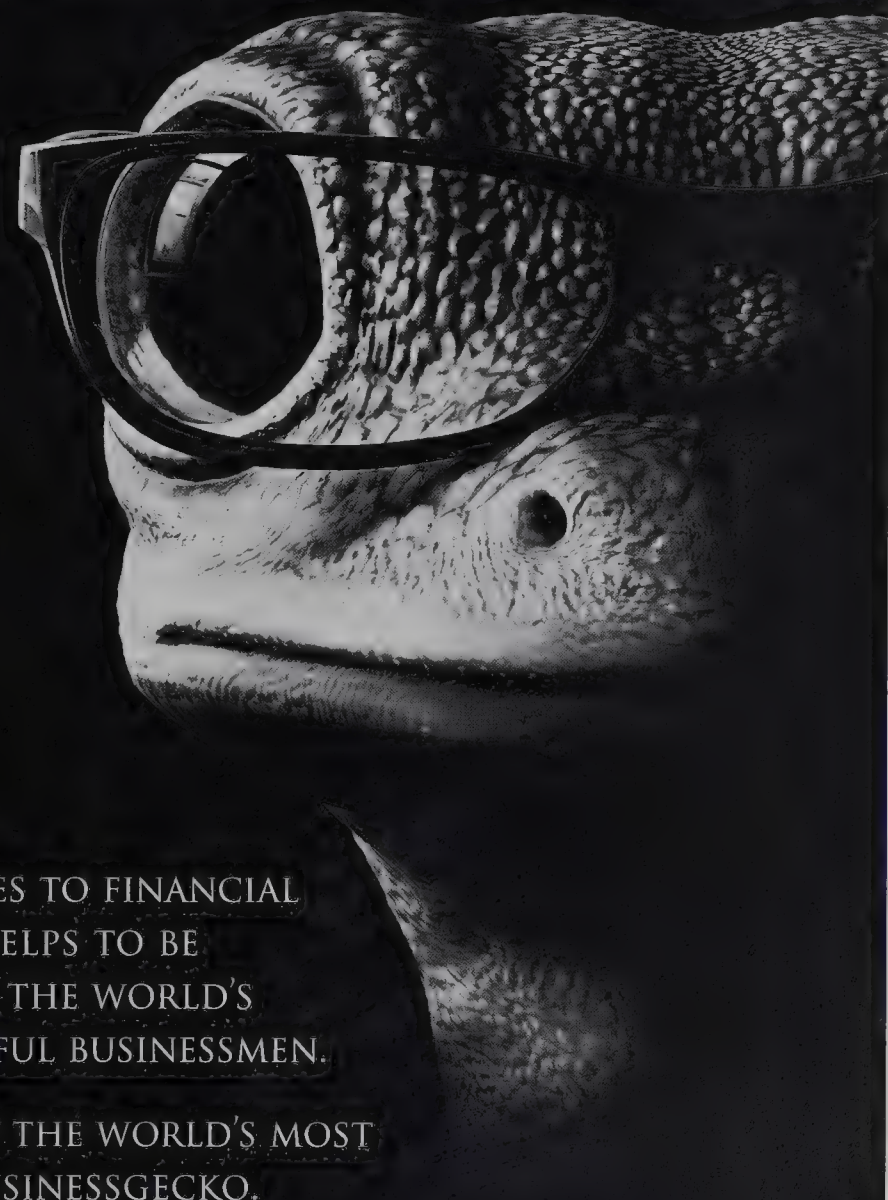


Yuliya Klichkova and a park ranger are on watch for bears in Kamchatka.

ON ASSIGNMENT Bear Tactics Photographer Randy Olson and his assistant, Yuliya Klichkova (above), spent a week working close to the bears of Kuril Lake in Kamchatka, Russia, hoping for an underwater shot. An opportunity finally arose, giving Olson time for just two frames—one of which was a knockout (see page 28). The salmon-obsessed beasts never hurt the interlopers, but Klichkova—who grew up in Kamchatka—kept flares in her pockets for quick access in case things got ugly. “They weren’t looking at us as a food source,” says Olson. “But,” he acknowledges, “when something that big is within four feet of you, it’s a little unnerving.”

GeoPuzzle Answers

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John-Joseph van Haelewyn

John and Shirley Spinelli included National Geographic in their estate plans.



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"We believe in the work of National Geographic and wanted to be involved," says John Spinelli. He and his wife Shirley grew up reading *National Geographic* magazine and passed that love on to their children and grandchildren. Now retired, they enjoy in-line skating, tennis and bird watching.

The Spinellis set up a charitable gift annuity which provides them with steady income and tax savings while supporting the Society's efforts worldwide. "National Geographic is an important source for solutions to the challenges facing our planet," says John. "We want the world to be in good shape for our grandchildren."

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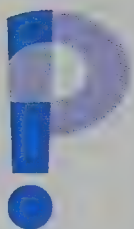
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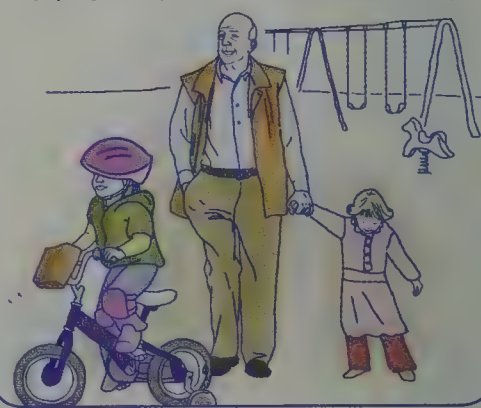


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Springs Eternal “Late that next afternoon we had our first close view of the enchanted land, when our party came upon the Mammoth Hot Springs,” wrote photographer William Henry Jackson, who accompanied explorer Ferdinand Hayden on his 1871 expedition to Yellowstone. Jackson packed, muleback, some 300 pounds of equipment on the journey, including hundreds of fragile glass plates upon which he developed images on-site. Yellowstone’s thermal pools proved to be more than just photogenic, according to Jackson; they also helped speed the photographic process: “By washing the plates in water that issued from the springs at 160° Fahrenheit, we were able to cut the drying time more than half.” His pictures were instrumental in persuading Congress to declare the area a U.S. national park—the country’s first—the next year. —Margaret G. Zackowitz

🔍 **Flashback Archive** Find all the photos at ngm.com.

PHOTO: WILLIAM HENRY JACKSON, NATIONAL GEOGRAPHIC STOCK

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No question is raised about the safety or effectiveness of TriCor or other fenofibrate drugs.

Defendants have denied any wrongdoing and liability but have agreed to the proposed settlement to resolve the controversy and to avoid the cost and expense of further litigation. The lawsuit, *In re TriCor Indirect Purchaser Antitrust Litigation*, C.A. No. 05-360 (SLR), is pending in U.S. District Court for the District of Delaware.

You may have important legal rights under this settlement, some of which you must act on by **September 15, 2009**.

Who is included?

The class includes consumers and insurance companies that purchased, paid for, or reimbursed purchases of fenofibrate products intended for consumption by yourself or your family, or, in the case of third-party payors, by members, employees, plan participants and beneficiaries or insureds, between April 9, 2002 and May 8, 2009. These products include TriCor, Lofibra, Antara, Triglide, and any available generic versions of these drugs.

What does the settlement provide?

The settlement provides \$65.7 million to pay to class members. It will be distributed according to the settlement. Any award for attorneys' fees,

expenses, and notice and administration costs will be deducted from this amount.

What are my legal rights?

- **Remain in the class and file a claim.** Claim forms must be postmarked by **September 15, 2009**. You will be bound by the terms of the settlement and you give up the right to sue at your own expense.
- **Remain in the class but object to (or comment on) the settlement.** If the settlement is approved and your objection is rejected, you are bound by the settlement terms and you will receive payment from the settlement fund (if you also file a claim). Objections and comments must be postmarked by **September 15, 2009** and they will be considered at a Fairness Hearing on **October 9, 2009**. If you want to appear at the settlement hearing, you must send in a written request for appearance postmarked by **September 25, 2009**.
- **Exclude yourself** and keep your right to sue at your own expense. Requests for exclusion must be postmarked by **September 15, 2009**.
- **Do nothing.** You remain in the class and give up your right to sue at your own expense. You will not receive any money unless you submit a claim.

The Court will determine whether to approve the settlement and attorneys' fees at a Fairness Hearing scheduled on **October 9, 2009 at 1:30 p.m.**

This is only a summary of the Proposed Settlement.

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HELP IS ON THE WAY: This never-before-seen photo captures the rapid shipment of free Presidential Armored Safes that are now being shipped to U.S. citizens all across the country. The World Reserve is handing out the Armored Safes free to the general public who rush to beat today's published deadline to buy up the newly released World Reserve Collection of never-circulated U.S. Gov't issued coins and currency. Those who get through by calling the National Delivery Hotline at 1-866-964-2951 and beat the 7 day order deadline will get the Armored Safes for free.

By Shawn Oyler

UMS - Imagine finally getting something that will never lose its value.

Sounds too good to be true?

Well, it's true and word is quickly spreading about the free handout of Armored Safes that are being stocked full of never-circulated U.S. Gov't issued coins and currency that by law will never be minted again.

These free Armored Safes are being turned over to the general public who make it in time to beat the order deadline for their share of the hoard of brilliant, never-circulated U.S. Gov't coins and currency before the 7 day shutoff.

"The frantic demand for U.S. Gov't coins has caused the U.S. Mint® to officially halt the sale of many of its most valuable coins," said lead consultant for the World Reserve Thomas C. Harris, Retired Deputy Director of the U.S. Treasury Bureau of Engraving and Printing.

"Today, the World Reserve began to release this hoard of U.S. Gov't coins and currency in a free Armored Safe to the general public. Having valuable U.S. Gov't coins serves as an economic life raft. This valuable Collection will never, never, never lose its face

value. You will always have something worth a lot of money," said Harris.

Here's the best part, among the U.S. Gov't issued coins and currency that everyone gets is the highly sought after American Eagle 1-ounce silver bullion coin made from solid .999 fine silver, 250 new 2005 U.S. Buffalo Nickels in sealed rolls, a banker's stack of historic \$2 bills and a full vault tube of the Presidential Golden Dollar Coins.

Here's why that is so important. Just think if you would have saved the same number of never-circulated Eisenhower Dollar coins from 1974. Remarkably, they would now be worth 500% more in collector value.

This gives you a hint that these are not the same grade as the coins found in loose change, or from the local bank. In fact, these coins remain in brilliant, never-circulated condition if left sealed and untouched.

U.S. Gov't Savings Bonds used to be a favorite way to keep money safe and popular to give as gifts. But no one can take a Savings Bond and go buy something with it.

That's why this hoard of valuable coins gives everyone the comfort of having full control of their money. No

matter what, they will never lose their U.S. cash value.

If times ever get really tough any coin in the hoard could be used to buy anything. But unless it is a good reason, only a fool would do that because this personal hoard of money is already worth so much more in collector value.

"So many people are buying up these coins. Even for those people who give away some of their collection as gifts, they are keeping the Armored Safe for themselves," said Robert Anthony, Director of the private World Reserve Monetary Exchange.

"This Safe is one of the absolute best places to keep valuables and important papers. People will now have a safe place to store their wills, guns, jewelry, antiques, keys, coins and even cash," Anthony said.

"The only problem the Safe creates is when it's time to read your Will. You need to make sure everyone knows who you want to leave it to," he said.

"When Americans get their hands on this Safe and their very own personal hoard of U.S. Gov't Coins, they'll really do a double take. Everyone will feel like they just won the lottery," he said. ■

How to get the free Armored Safes

All those who beat the 7 day order deadline for each personal hoard of U.S. Gov't issued coins and currency from the World Reserve Collection will actually be awarded the Presidential Armored Safes absolutely free.

Eligibility: Certain restrictions apply: Open to the public only, sorry no dealers. Those who miss the 7 day deadline will be turned away from this free offer and required to wait for future announcements, in this or other publications. The entire World Reserve Collection must be obtained to get the safe free.

Terms & Conditions: To receive delivery of your free Armored Safe, you'll only need to cover \$149 for the first shipment of coins. Then the same amount for the last remaining shipment to cover the entire collection of 267 U.S. Gov't coins. THE NO-WORRY GUARANTEE ENSURES THAT REFUNDS BE GRANTED FOR ALL ITEMS PROPERLY RETURNED, LESS SHIPPING FOR 90 DAYS FROM THE DAY YOU RECEIVE YOUR SAFE AND FIRST SHIPMENT. THAT MEANS, CANCELLATION WILL REQUIRE THE RETURN OF THE FREE ARMORED SAFE. FAILURE TO DO SO WILL REQUIRE REMITTANCE FOR THE SAFE OF FOUR HUNDRED AND THIRTY SIX DOLLARS. THE WORLD RESERVE MONETARY EXCHANGE, INC. IS NOT AFFILIATED WITH THE U.S. GOVERNMENT, A BANK OR ANY GOVERNMENT AGENCY. THE INCREASE IN COLLECTIBLE VALUE OF CERTAIN PRIOR ISSUES OF U.S. COINS DOES NOT GUARANTEE THAT CURRENT ISSUES WILL ALSO INCREASE IN VALUE. OH AND FL RESIDENT TRANSACTIONS REQUIRE THE REMITTANCE OF APPLICABLE SALES TAX. SORRY NO SHIPMENTS TO VT AND MA RESIDENTS. ADVERTISEMENT FOR WORLD RESERVE MONETARY EXCHANGE, INC. 8000 FREEDOM AVE., N. CANTON OH 44720.

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7 Smart places to stash your cash

By Robert Anthony

So you're still hiding money under the mattress or in the bread box?

Well, you're not alone. Ever since financial institutions have been dropping like flies, millions of Americans have stopped relying solely on their banks.

1. Be sure your bank is insured. If you're not sure if your bank is FDIC insured find out or get your money out. They only have enough cash on hand to cover about 2% of nationwide deposits. So it's not always wise to keep all your eggs in one basket.

2. Start and grow a coin collection. Coin collections are tangible assets that will always keep their face value, instead of just owning stocks that could depreciate or lose you money.

3. Keep cash safe at home. Cash is King. Believe it, but remember not to keep it in a thief's favorite spot; like in the bread box or the mattress. These will never have the protection that a quality home safe can provide.

4. Savings Bonds, an old favorite. Savings Bonds are an easy way for your money to stay safe in the future. However, if lost or stolen they could be difficult to replace unless the serial number was kept in a safe place.

5. Gold and silver still shine. If you own gold or silver, great, hold on to it. But if you don't, one of your best bets is to try to get as many U.S. Gov't issued gold and silver coins as you can.

6. Hold on to real estate. With interest rates at historic all-time lows the market is sure to recover and property values will once again bounce back. So those who hold on to their homes for the long term will likely reap the benefits of these investments.

7. Buy a good safe. Home safes become an absolute necessity during economic turmoil. But, because of the huge spike in recent sales, safes may be hard to come by.

With all this you'll be much safer, just in case your bank is the next to fail. ■

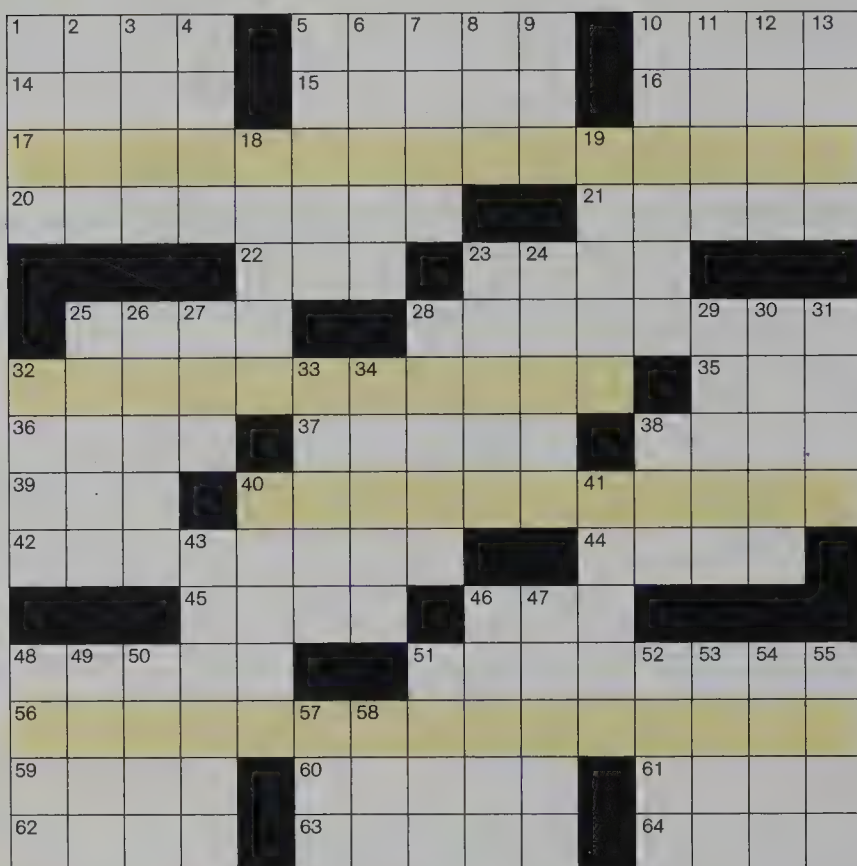


■ **LIKE WINNING THE LOTTERY:** Everyone gets the personal hoard consisting of 267 never-circulated U.S. Gov't coins and currency including 12 Presidential Golden Dollar Coins in a sealed Vault Roll and a heavy vault brick containing 250 never-circulated U.S. Buffalo Nickels and, best of all, a solid .999 fine silver American Silver Eagle and a banker's stack of 4 historic \$2 bills. If times ever get really tough, any coin in this collection could be used to buy anything. Keep it as long as you can because this hoard is already worth so much more than face value.



■ **NO MORE WORRIES:** Carol Ford of Perry, OH said she hit the jackpot when her free Armored Safe was delivered. "I already have some old coins, but I wanted these U.S. coins as a nice nest egg. Now I can keep all my important papers and my Dad's gun in my new safe," she said.

GEOPUZZLE



Depth in Venice

Puzzle by Cathy Allis

Venice's watery setting is part of its allure but can take a toll. The story on page 88 mulls the city's mystique—and the plans to protect this treasure from the sea. The tinted clues for this puzzle probe the threats to Venice.

ACROSS

- 1 Suds source
- 5 Gelato, for one
- 10 Spiced Indian tea
- 14 It means "bone," on Italian menus
- 15 Instruction on a Wonderland cake
- 16 Vaporetti : motors :: gondolas : —
- 17 What the *acqua alta* does in a place where Venetians shop?
- 20 Venetian deluge of a sort
- 21 Straight from the vine
- 22 Dissenting vote
- 23 "This," in Spain

- 25 Deer dad
- 28 Erudite types
- 32 Venice has to implement one often?
- 35 Predetermined
- 36 Ill-mannered
- 37 Ms. Jones, Grammy-winning singer of "Don't Know Why"
- 38 Org. that fights for rights
- 39 Muckraker Tarbell
- 40 Delivers financial aid in Venice, not always via a canal?
- 42 A medium seen in Venice's Correr Museum

- 44 Venice is one
- 45 Song and dance, e.g.
- 46 It's *due* in Venice?
- 48 Readies for the OR
- 51 Fortifies, as with sandbags
- 56 Venetian business event during high water?
- 59 Its cap. is Quito
- 60 Gypsy composer Jule
- 61 Over again
- 62 Related by blood
- 63 Strained, as one's patience
- 64 Four-stringed instruments, for short

DOWN

- 1 Like the g's in San Giorgio Maggiore
- 2 Norway's largest city
- 3 Not worth — (as valueless as an old coin)
- 4 Indigent
- 5 Giuseppe's bride in *The Gondoliers*
- 6 Unkempt
- 7 Ordinal endings
- 8 Soul, in Nice and Nancy
- 9 President pro —
- 10 Bull pen?
- 11 Saltwater cousin of the cod
- 12 Greek war god
- 13 Narrow strip of land: abbr.
- 18 Australian canine
- 19 "Sweet" stream in a Robert Burns poem
- 23 Dazzling display
- 24 Persian royals
- 25 Mecca native, e.g.
- 26 Kind of wave Venice doesn't welcome
- 27 Suds of a sort
- 28 No-fat nursery rhyme fellow
- 29 English race that's always a tie?
- 30 Race involving handoffs
- 31 Bowl over
- 32 Verve
- 33 Needing a new bulb, perhaps
- 34 Animation creations, informally
- 38 Fighting foe of Frazier and Foreman
- 40 Iranian language
- 41 Squash variety
- 43 New Guinea native
- 46 Yours of yore
- 47 Courted
- 48 Court entry
- 49 Humphrey's *Casablanca* role
- 50 Prefix with distant
- 51 Mythological river encircling Hades
- 52 Jacob's womb mate
- 53 Went the way of Venice's foundations
- 54 "Gold" keeper in a 1997 film title
- 55 Seating at St. Mark's
- 57 Widely used spring-to-fall hrs.
- 58 Glance or loss lead-in

Answers in
Inside Geographic



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**DRAMA IN A
PENGUIN NURSERY 54**

**SOMALIA: THE NUMBER ONE
FAILED NATION 70**

SNEAKY, SEXY ORCHIDS 100

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THINK



Conversations for a Smarter Planet

A mandate for change is a mandate for smart.

The world is ready for change – that much is clear.

For leaders of all kinds, this moment presents a rare opportunity. Our planet is not just getting smaller and flatter. It is also becoming smarter. And that means we have the potential to change the way the world literally works.

Computational power is now being put into things we wouldn't recognize as computers – cars, appliances, cameras, roadways...even pharmaceuticals and livestock. We are interconnecting all of this through the Internet, which has come of age. And we are applying powerful new systems and sophisticated analytics to turn oceans of data into insight, knowledge and intelligence.

Consider the changes already under way.

Smart traffic systems are helping to reduce gridlock by 20%, cutting pollution and increasing ridership on public transit.

Smart food systems based on RFID technology embedded into supply chains are monitoring meat, poultry and other items from the farm to the super-market shelf.

Smart healthcare systems are helping to lower the cost of therapy by as much as 90%.

Police departments are correlating street-level information from myriad observations and devices to identify crime patterns – helping prevent crime, rather than simply punishing it.

The list is long, and the transformation is just beginning. Its benefits will be reaped not only by large enterprises, but also by mid-sized and small companies – the engines of economic growth everywhere – and by individuals and communities around the world.

Imagine how a smarter planet will transform *all* the things we seek. The ways we pursue economic growth, societal progress, environmental sustainability and cures for disease. The way we interact with each other and with the world.

The opportunity is before us, and the moment will not last forever. Will we seize it? As we look to stimulate our economies and rebuild our infrastructure, will we simply repair what's broken? Or will we prepare for a smarter future?

Join us at **ibm.com/smarterplanet**



6

HUGGIES

NATURAL CARE

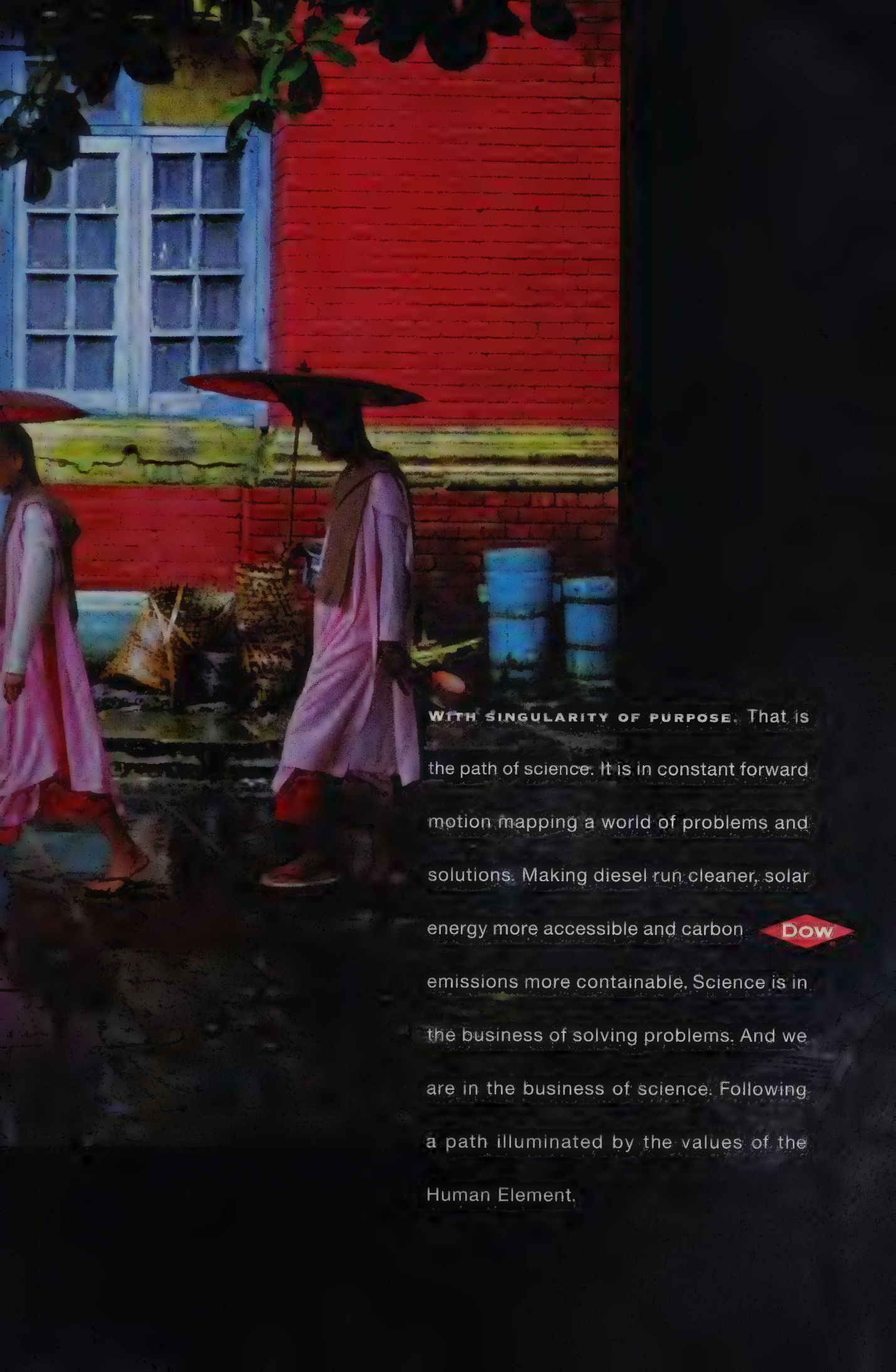
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CHRISTIAN ZIEGLER (ALL)

The 25,000 species of orchids dazzle with diversity. Story on page 100.

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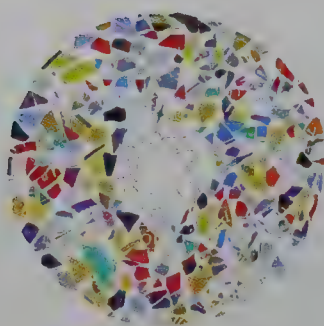
GeoPuzzle

On the Cover

Two views show lower Manhattan then (1609, computer-generated image) and now (2009, aerial shot).

CGI by Markley Boyer

Photo by Robert Clark



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Our map of New York City won't guide you to Carnegie Hall. Instead, click on modern landmarks to see streams, swamps, and other features from 400 years ago.

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It may seem like madness for a photographer to repeatedly risk his life in one of the most dangerous places on Earth, but that is exactly what Pascal Maitre did on five visits to Somalia. (He photographed the street scene above in Mogadishu.) Without a stable government since 1991, the country is arguably the scene of Africa's worst humanitarian crisis. It's one of the deadliest places a journalist can be. Pascal began photographing there in 2002 and established the relationships that made this month's "Shattered Somalia" story possible. In 2008 he returned with writer Robert Draper.

"When I first came to Somalia, it was terrible; we felt it couldn't be more down," Pascal told me. "I'd return, and it was even darker and more difficult. We would arrive at a feeding center. People would be happy we'd come. Five minutes later they'd say: 'Don't stay too long. The militia will shoot you.'" Despite the danger, he persisted. Accompanied by bodyguards, he'd spend time in a Mogadishu hospital where patients were so beaten down they were beyond tears. "Their eyes were dry. They were no longer crying. They have seen so much. There is no sense of normal life."

To bear witness to such suffering requires the highest measure of compassion and conviction. That is why Pascal Maitre kept going back. "Somalis came up to me every day and asked, 'Why has the world abandoned us?'" he says. "I'm hoping my pictures can help just a little bit."

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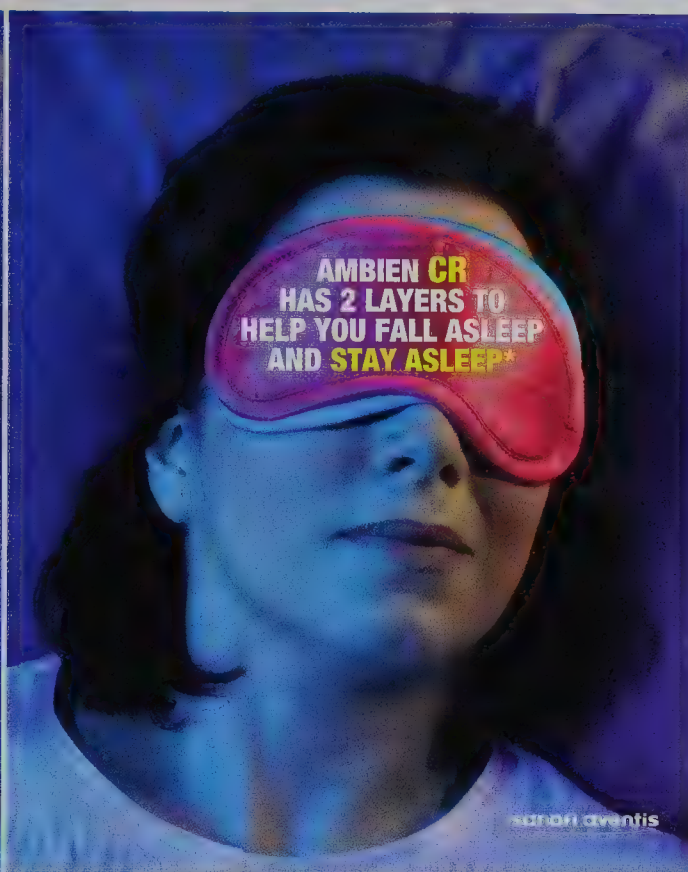
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AMBIEN CR® (ām'bē-ən see ahr) **C-IV**

(zolpidem tartrate extended-release tablets)

Read the Medication Guide that comes with AMBIEN CR before you start taking it and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking to your doctor about your medical condition or treatment.

What is the most important information I should know about AMBIEN CR?

After taking AMBIEN CR, you may get up out of bed while not being fully awake and do an activity that you do not know you are doing. The next morning, you may not remember that you did anything during the night. You have a higher chance for doing these activities if you drink alcohol or take other medicines that make you sleepy with AMBIEN CR. Reported activities include:

- driving a car ("sleep-driving")
- making and eating food
- talking on the phone
- having sex
- sleep-walking

Call your doctor right away if you find out that you have done any of the above activities after taking AMBIEN CR.

Important:

1. Take AMBIEN CR exactly as prescribed

- Do not take more AMBIEN CR than prescribed.
- Take AMBIEN CR right before you get in bed, not sooner.

2. Do not take AMBIEN CR if you:

- drink alcohol
- take other medicines that can make you sleepy. Talk to your doctor about all of your medicines. Your doctor will tell you if you can take AMBIEN CR with your other medicines.
- cannot get a full night's sleep

What is AMBIEN CR?

AMBIEN CR is a sedative-hypnotic (sleep) medicine. AMBIEN CR is used in adults for the treatment of a sleep problem called insomnia. Symptoms of insomnia include:

- trouble falling asleep
- waking up often during the night

AMBIEN CR is not for children.

AMBIEN CR is a federally controlled substance (C-IV) because it can be abused or lead to dependence. Keep AMBIEN CR in a safe place to prevent misuse and abuse. Selling or giving away AMBIEN CR may harm others, and is against the law. Tell your doctor if you have ever abused or have been dependent on alcohol, prescription medicines or street drugs.

Who should not take AMBIEN CR?

Do not take AMBIEN CR if you are allergic to anything in it. See the end of this Medication Guide for a complete list of ingredients in AMBIEN CR.

AMBIEN CR may not be right for you. Before starting AMBIEN CR, tell your doctor about all of your health conditions, including if you:

- have a history of depression, mental illness, or suicidal thoughts
- have a history of drug or alcohol abuse or addiction
- have kidney or liver disease
- have a lung disease or breathing problems
- are pregnant, planning to become pregnant, or breastfeeding

Tell your doctor about all of the medicines you take including prescription and nonprescription medicines, vitamins and herbal supplements. Medicines can interact with each other, sometimes causing serious side effects. **Do not take AMBIEN CR with other medicines that can make you sleepy.**

Know the medicines you take. Keep a list of your medicines with you to show your doctor and pharmacist each time you get a new medicine.

How should I take AMBIEN CR?

- Take AMBIEN CR exactly as prescribed. Do not take more AMBIEN CR than prescribed for you.
- **Take AMBIEN CR right before you get into bed.**
- **Do not take AMBIEN CR unless you are able to stay in bed a full night (7-8 hours) before you must be active again.**
- Swallow AMBIEN CR Tablets whole. Do not chew or break the tablets. Tell your doctor if you cannot swallow tablets whole.
- For faster sleep onset, AMBIEN CR should NOT be taken with or immediately after a meal.
- Call your doctor if your insomnia worsens or is not better within 7 to 10 days. This may mean that there is another condition causing your sleep problems.
- If you take too much AMBIEN CR or overdose, call your doctor or poison control center right away, or get emergency treatment.

What are the possible side effects of AMBIEN CR?

Serious side effects of AMBIEN CR include:

- **getting out of bed while not being fully awake and do an activity that you do not know you are doing.** (See "What is the most important information I should know about AMBIEN CR?")
- **abnormal thoughts and behavior.** Symptoms include more outgoing or aggressive behavior than normal, confusion, agitation, hallucinations, worsening of depression, and suicidal thoughts or actions.
- **memory loss**
- **anxiety**
- **severe allergic reactions.** Symptoms include swelling of the tongue or throat, trouble breathing, and nausea and vomiting. Get emergency medical help if you get these symptoms after taking AMBIEN CR.

Call your doctor right away if you have any of the above side effects or any other side effects that worry you while using AMBIEN CR.

The most common side effects of AMBIEN CR are:

- headache
- sleepiness
- dizziness
- You may still feel drowsy the next day after taking AMBIEN CR. **Do not drive or do other dangerous activities after taking AMBIEN CR until you feel fully awake.**

After you stop taking a sleep medicine, you may have symptoms for 1 to 2 days such as: trouble sleeping, nausea, flushing, lightheadedness, uncontrolled crying, vomiting, stomach cramps, panic attack, nervousness, and stomach area pain. These are not all the side effects of AMBIEN CR. Ask your doctor or pharmacist for more information. Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store AMBIEN CR?

- Store AMBIEN CR at room temperature, 59° to 77°F (15° to 25° C).
- **Keep AMBIEN CR and all medicines out of reach of children.**

General Information about AMBIEN CR

- Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide.
- Do not use AMBIEN CR for a condition for which it was not prescribed.

- Do not share AMBIEN CR with other people, even if you think they have the same symptoms that you have. It may harm them and it is against the law.

This Medication Guide summarizes the most important information about AMBIEN CR. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about AMBIEN CR that is written for healthcare professionals. For more information about AMBIEN CR, call 1-800-633-1610 or visit www.ambien-cr.com.

What are the ingredients in AMBIEN CR?

Active Ingredient: Zolpidem tartrate

Inactive Ingredients: The 6.25 mg tablets contain: colloidal silicon dioxide, hypromellose, lactose monohydrate, magnesium stearate, microcrystalline cellulose, polyethylene glycol, potassium bitartrate, red ferric oxide, sodium starch glycolate, and titanium dioxide. The 12.5 mg tablets contain: colloidal silicon dioxide, FD&C Blue #2, hypromellose, lactose monohydrate, magnesium stearate, microcrystalline cellulose, polyethylene glycol, potassium bitartrate, sodium starch glycolate, titanium dioxide, and yellow ferric oxide.

Rx Only

This Medication Guide has been approved by the U.S. Food and Drug Administration.

sanofi-aventis U.S. LLC

Bridgewater, NJ 08807

January 2008a

AMBCR-JAN08a-M-Ab

MEDICATION GUIDE

AMBIEN® (ām'bē-ən) Tablets C-IV (zolpidem tartrate)

Read the Medication Guide that comes with AMBIEN before you start taking it and each time you get a refill. There may be new information. This Medication Guide does not take the place of talking to your doctor about your medical condition or treatment.

What is the most important information I should know about AMBIEN?

After taking AMBIEN, you may get up out of bed while not being fully awake and do an activity that you do not know you are doing. The next morning, you may not remember that you did anything during the night. You have a higher chance for doing these activities if you drink alcohol or take other medicines that make you sleepy with AMBIEN. Reported activities include:

- driving a car ("sleep-driving")
- making and eating food
- talking on the phone
- having sex
- sleep-walking

Call your doctor right away if you find out that you have done any of the above activities after taking AMBIEN.

Important:

1. Take AMBIEN exactly as prescribed

- Do not take more AMBIEN than prescribed.
- Take AMBIEN right before you get in bed, not sooner.

2. Do not take AMBIEN if you:

- drink alcohol
- take other medicines that can make you sleepy. Talk to your doctor about all of your medicines. Your doctor will tell you if you can take AMBIEN with your other medicines.
- cannot get a full night's sleep

What is AMBIEN?

AMBIEN is a sedative-hypnotic (sleep) medicine. AMBIEN is used in adults for the short-term treatment of a sleep problem called insomnia. Symptoms of insomnia include:

- trouble falling asleep

AMBIEN is not for children.

AMBIEN is a federally controlled substance (C-IV) because it can be abused or lead to dependence. Keep AMBIEN in a safe place to prevent misuse and abuse. Selling or giving away AMBIEN may harm others, and is against the law. Tell your doctor if you have ever abused or have been dependent on alcohol, prescription medicines or street drugs.

Who should not take AMBIEN?

Do not take AMBIEN if you are allergic to anything in it.

See the end of this Medication Guide for a complete list of ingredients in AMBIEN.

AMBIEN may not be right for you. Before starting AMBIEN, tell your doctor about all of your health conditions, including if you:

- have a history of depression, mental illness, or suicidal thoughts
- have a history of drug or alcohol abuse or addiction
- have kidney or liver disease
- have a lung disease or breathing problems
- are pregnant, planning to become pregnant, or breastfeeding

Tell your doctor about all of the medicines you take including prescription and nonprescription medicines, vitamins and herbal supplements. Medicines can interact with each other, sometimes causing serious side effects. **Do not take AMBIEN with other medicines that can make you sleepy.**

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How should I take AMBIEN?

- Take AMBIEN exactly as prescribed. Do not take more AMBIEN than prescribed for you.
- **Take AMBIEN right before you get into bed.**
- **Do not take AMBIEN unless you are able to stay in bed a full night (7-8 hours) before you must be active again.**
- For faster sleep onset, AMBIEN should NOT be taken with or immediately after a meal.
- Call your doctor if your insomnia worsens or is not better within 7 to 10 days. This may mean that there is another condition causing your sleep problem.
- If you take too much AMBIEN or overdose, call your doctor or poison control center right away, or get emergency treatment.

What are the possible side effects of AMBIEN?

Serious side effects of AMBIEN include:

- **getting out of bed while not being fully awake and do an activity that you do not know you are doing.** (See “What is the most important information I should know about AMBIEN?”)
- **abnormal thoughts and behavior.** Symptoms include more outgoing or aggressive behavior than normal, confusion, agitation, hallucinations, worsening of depression, and suicidal thoughts or actions.
- **memory loss**
- **anxiety**
- **severe allergic reactions.** Symptoms include swelling of the tongue or throat, trouble breathing, and nausea and vomiting. Get emergency medical help if you get these symptoms after taking AMBIEN.

Call your doctor right away if you have any of the above side effects or any other side effects that worry you while using AMBIEN.

The most common side effects of AMBIEN are:

- drowsiness
- dizziness
- diarrhea
- “drugged feelings”
- You may still feel drowsy the next day after taking AMBIEN. **Do not drive or do other dangerous activities after taking AMBIEN until you feel fully awake.**

After you stop taking a sleep medicine, you may have symptoms for 1 to 2 days such as: trouble sleeping, nausea, flushing, lightheadedness, uncontrolled crying, vomiting, stomach cramps, panic attack, nervousness, and stomach area pain.

These are not all the side effects of AMBIEN. Ask your doctor or pharmacist for more information.

Call your doctor for medical advice about side effects. You may report side effects to FDA at 1-800-FDA-1088.

How should I store AMBIEN?

- Store AMBIEN at room temperature, 68° to 77°F (20° to 25°C).
- **Keep AMBIEN and all medicines out of reach of children.**

General Information about AMBIEN

- Medicines are sometimes prescribed for purposes other than those listed in a Medication Guide.
- Do not use AMBIEN for a condition for which it was not prescribed.
- Do not share AMBIEN with other people, even if you think they have the same symptoms that you have. It may harm them and it is against the law.

This Medication Guide summarizes the most important information about AMBIEN. If you would like more information, talk with your doctor. You can ask your doctor or pharmacist for information about AMBIEN that is written for healthcare professionals. For more information about AMBIEN, call 1-800-633-1610.

What are the ingredients in AMBIEN?

Active Ingredient: Zolpidem tartrate

Inactive Ingredients: hydroxypropyl methylcellulose, lactose, magnesium stearate, micro-crystalline cellulose, polyethylene glycol, sodium starch glycolate, and titanium dioxide. In addition, the 5 mg tablet contains FD&C Red No. 40, iron oxide colorant, and polysorbate 80.

Rx Only

This Medication Guide has been approved by the U.S. Food and Drug Administration.

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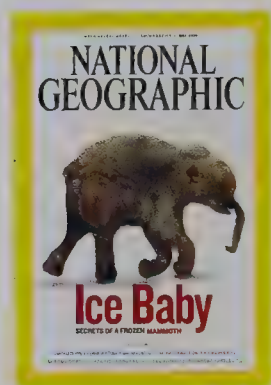


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May 2009

Ice Baby

The article about the discovery and study of the baby mammoth left me weeping. I can only hope that after all the tests have been done and her time in the laboratory is finished, she will be given the respect she is due and not stuffed away in some freezer, forgotten—or worse, paraded around from museum to museum as a freak of history. She is a treasure and should be treated as such.

KELLEY SNOWDEN
Overton, Texas

Recipe for a Resurrection

With so many human beings dying daily and so many animals near extinction, why would anyone want to spend the time, money, and research to have a mammoth walk again? Let mankind try to save what is living now.

LESLIE WHITE
Santa Barbara, California

The potential consequences of resurrecting extinct species range from disruption of modern ecosystems and species to exploitation to global indifference to the plight of currently endangered species.

To be sure, there are potential benefits as well, but the pros and cons should be explored by all before we take such giant leaps, lest we find ourselves in a crisis. Author Tom Mueller's piece, which focuses more on the scientific feasibility of cloning mammoths than the far more difficult question posed on the magazine's cover ("Should we clone extinct animals?"), presents only the views of DNA scientists to the exclusion of ethicists, ecologists, and other relevant experts. It does not do the subject the justice it deserves.

COREY SALSBERG
Needham, Massachusetts

Arctic Landgrab

Reading about the Arctic oil rush is like finding a vast outdoor institution for the terminally deluded. The fossil-fuel people act as though the global warming crisis were a quaint story from some other planet. They remind me of what Joseph Conrad said about a character in *Typhoon*: "Omens were as nothing to him, and he was unable to discover the message of a prophesy till the fulfillment had brought it home to his very door." Given what the worst-case scenarios now look like, there is no sane business case for further oil exploration anywhere on Earth.

LES CARTER
Rossland, British Columbia

Once we get past all the posturing, nationalism, and chest thumping, the major concern over this extremely fragile environment has to be who sets the environmental rules. While most nations are aware of the impact that development can have on the

ecosystem, the Russians are oblivious to their carelessness. Combined with their record of sloppy engineering, that should give us all cause for concern. One need only reference Chernobyl and the *Kursk* submarine incident as examples. However, we in North America also have a less than enviable track record. Before any further intrusion into the Arctic, could we not call a conference of all participating nations and agree to strict environmental standards? Let us pray that stewardship of the Arctic will be a result of leadership by good example rather than by force.

DON MACMILLAN
Oakville, Ontario

Your article mentioned that Barrow, Alaska, is the northernmost town in North America. Aren't Sachs Harbour, Resolute, and Grise Fiord, Canada, all located farther north than Barrow? I've seen these places described as hamlets, but I don't know if they are officially towns, villages, or something else. Is this just an issue of semantics?

GABRIEL WALSH
New York, New York

The communities mentioned are so small they are not considered towns. Sachs Harbour and Grise Fiord, for example, have populations of only about a hundred residents each.

Contact Us

Email ngsforum@ngm.com

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Ancient Mariner

Your article will be an informative teaching tool in our forthcoming tropical field-biology course visit to Trinidad, which includes a night beach trip to see leatherbacks nesting. I spent many nights in the 1980s on "turtle walks" along the southeastern coast of India. We collected olive ridley eggs and incubated them in a protective hatchery. Since our hatchery was farther from the beach than the actual nests, we now realize that we may have done more harm than good, because incubation temperatures influence the sex ratio of hatchlings. Warmer temperatures produce more females! Leatherbacks may be more vulnerable, because they seem sensitive to even slight

deviations from the temperature at which equal numbers of both sexes are produced.

RAGUPATHY KANNAN
Professor of Biology

University of Arkansas–Fort Smith
Fort Smith, Arkansas

Searching for Shangri-La

When I backpacked through Zhongdian in 2005, it was a fairly forgettable city still in the process of being rebuilt for tourism. Shortly after arriving, my companions and I were walking down an alley with "traditional" wooden buildings going up when a carpenter and his apprentice beckoned us to their workshop for some tea. As the carpenter tossed wood scraps into a small stove, I asked him with my basic

Chinese about the name change to Shangri-La and the buildings going up. His response was easy to understand: "It's all fake." Everyone we met still called the city Zhongdian, and the tourist center of town ended up being the least interesting part of it all. We found out as we continued our trip that western Yunnan is full of many more fascinating places lacking kitschy names from English novels.

GABE GOSSETT
Madison, Wisconsin

Up on the Roof

As I sit overlooking so many flat roofs in central London, I realize the untapped potential. I feel that we have so far to go, but suddenly attainability seems possible, owing to

the commercial benefits. Imagine the increased amenity to our living spaces as we could grow apples, pears, honey, and rice on our roofs whilst we enjoy a glass of our favorite tippie—and the fantastic skylines of our cities. Absolutely fabulous!

EDDIE SMITH
London, England

Using a two-page photograph of Chicago's City Hall roof garden to launch your article is a perfect example of image over substance. Here is a city of nearly three million people that has never had—and is still far from—a working recycling program. A city that still favors cars over public transit. The second irony in the photo is the slanting-glass Thompson

Center building shown to the left of City Hall. When it opened for business, the sun made it so hot that employees set beach umbrellas over their desks until the air-conditioning was upgraded and turned to high.

BILL WADE
Chicago, Illinois

Flat roofs in humid climates have always been a bad idea. But there are simpler ways to accomplish the goals: permeable pavers, regular sloping roofs that are insulated enough to hold a blanket of snow in winter, rain barrels and cisterns, fewer lawns, and more areas of native-plant ecosystems. And no-tech "green roofs" continue to be practicable. In Midewin National Tallgrass Prairie the remaining ammo

bunkers of the former Joliet arsenal have their sloping sides of reinforced concrete covered with soil and local native grasses, just like the earth lodges of the tribes of the upper Missouri River that Lewis and Clark visited.

JEAN SMILINGCOYOTE
Chicago, Illinois

I would think it counterproductive to grow much of anything on roofs that are ten-plus stories high. Imagine the difficulties of getting water, fertilizer, et cetera up to the plants—plus the air pollution.

PHILLIP TUTTLE
Carthage, Illinois

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The Great Wall

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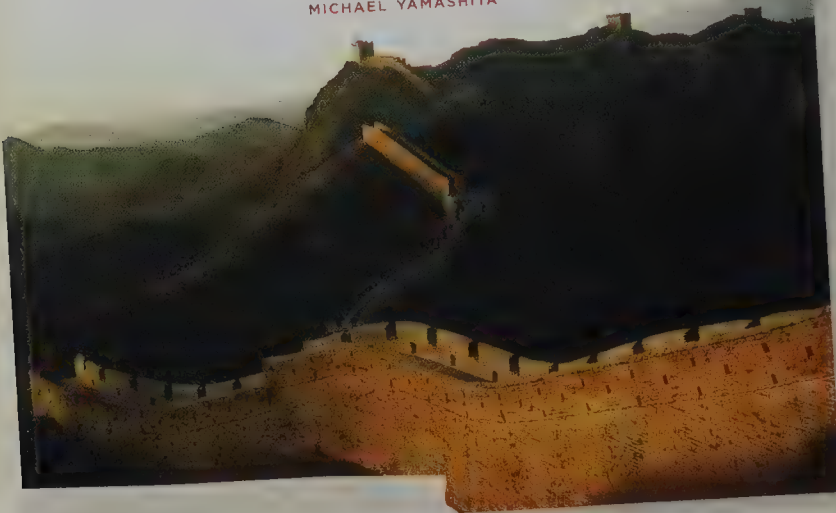
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MICHAEL YAMASHITA



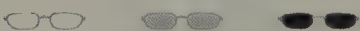
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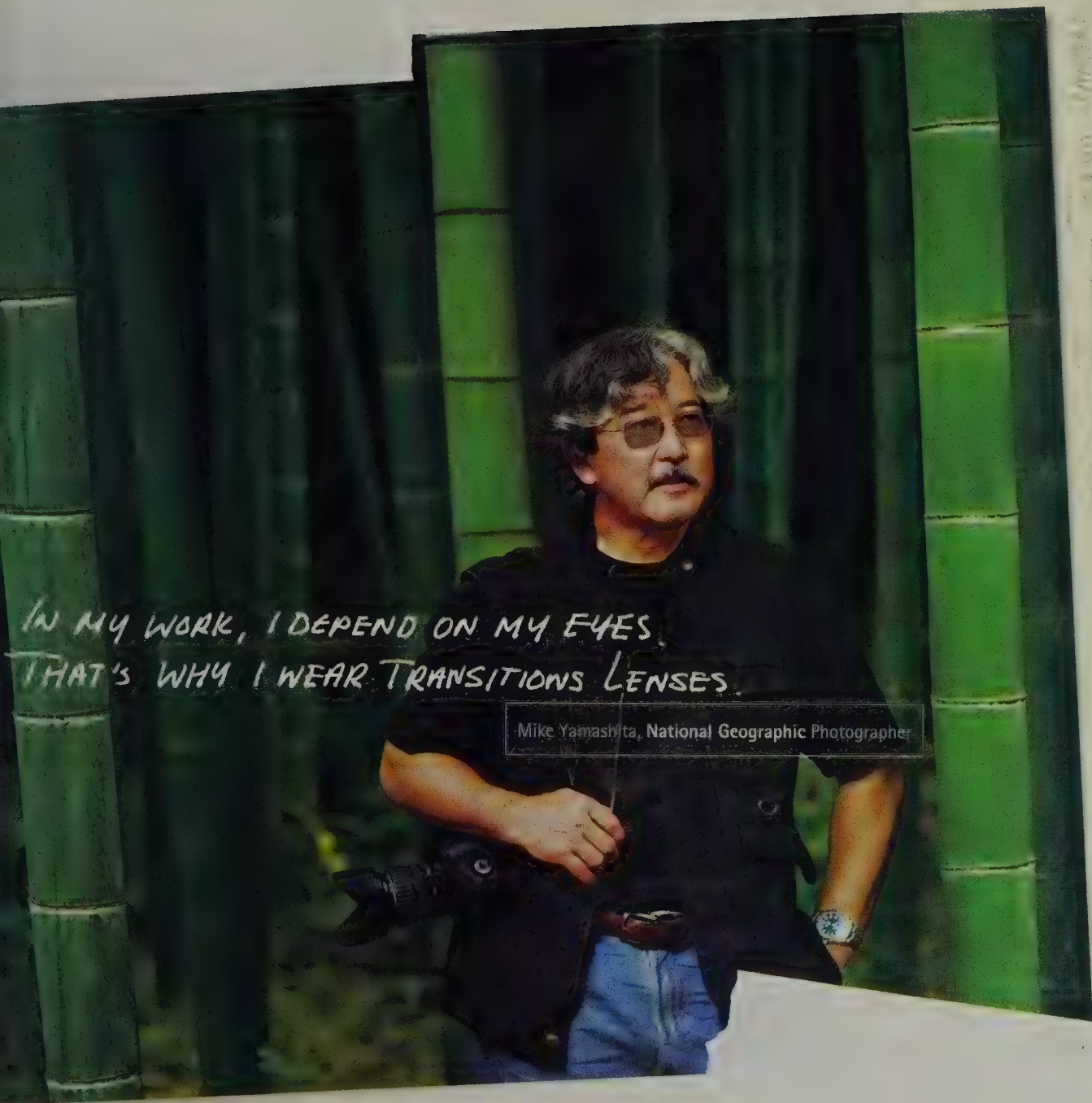


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Light and Shadow Whether it's a glowing critter or a rain-slick cityscape, interplay of light and dark can illuminate and inspire. Some call it chiaroscuro. We call it the makings of a great shot. Have you taken a picture like that? Send it to us. Every month, this page features two photos: one chosen by our editors, one chosen by our readers via online voting. For guidelines, a submission form, and more information, go to ngm.com/yourshot.



EDITORS' CHOICE

James Snyder West Palm Beach, Florida

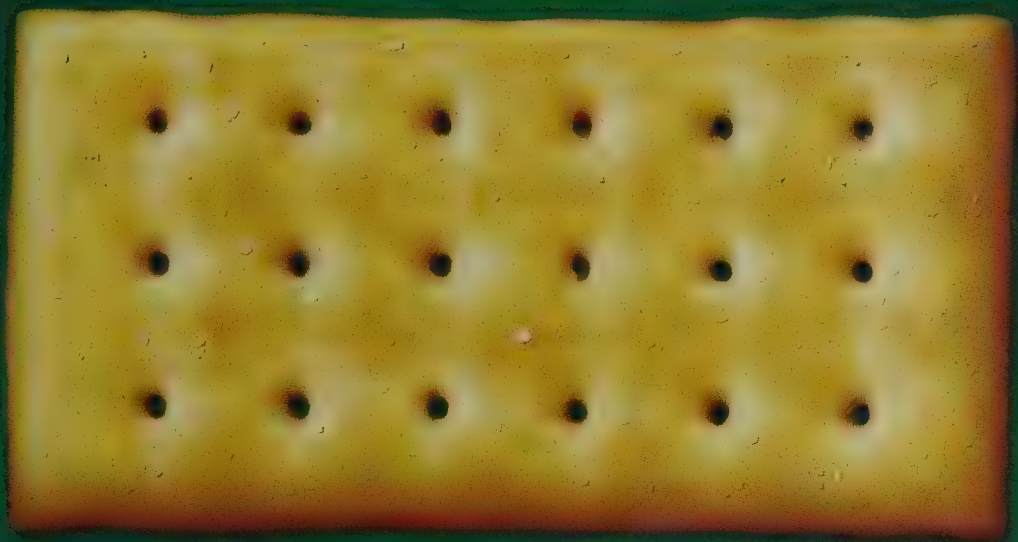
One evening Snyder noticed something bizarre in his backyard: A frog hugging a mango tree had swallowed a Christmas light. The 29-year-old snapped this shot, then worked to free the frog.

Navid Baraty San Francisco, California

A 28-year-old Web developer, Baraty likes shooting in the rain "because of the wonderful lighting from all the reflective surfaces." He took this gift of a picture just days before Christmas, as shoppers trundled through Union Square.



READERS' CHOICE



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The springtime Nowruz holiday is a busy time for families in Kokand, a thriving city in Uzbekistan's Fergana Valley.

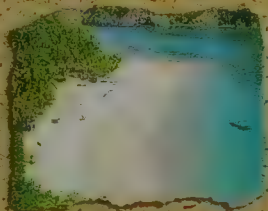
More of photojournalist Carolyn Drake's work can be found at carolyndrake.com.

Inside Uzbekistan A country governed by fear is a challenge for a foreigner with cameras and questions. I'd heard stories about this former Soviet republic from ethnic Crimean Tatars who'd left, yet I had few expectations when I arrived. I certainly didn't think it would be so hard to connect with people. Uzbeks don't speak freely, especially to outsiders, and with good reason: The current regime has a record of intimidating and torturing those who have strayed beyond its control. The irony is that, with so few jobs, survival for many depends on deeply unofficial activities such as smuggling, doing business in black markets, and growing unapproved crops.

The heart of Uzbekistan's sanctioned economy is cotton. People are forced to work their lands and sell their yield at low cost to the government, which exports it at great profit—an unfair system made possible by a network of poorly designed, environmentally dangerous canals that effectively carve the country into fiefs.

Given this climate, it was natural that a photographer would make people nervous. Still, some Uzbeks were willing to share with me the rituals of their daily lives, and I tried to use those chances to make tangible images of abstractions like silence and suspicion. I think the picture of the café (above) comes closest to achieving this. It's an everyday scene, yet the reflected shadow above the man's head suggests surveillance, points to an identity hidden just beneath the surface. That was the Uzbekistan I experienced.

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Forty days before this picture was taken, these traditional Uzbek clothes—here adorning the walls in a Khanabad home and worn by the newlywed in the mirror—were wedding presents. The custom is to keep such gifts on display long after the ceremony, so that guests dropping by may admire them.



In Karakalpakstan, an autonomous region of Uzbekistan, schoolgirls share a backstage laugh while rehearsing a performance for Nowruz, the spring holiday signaling the start of a new year.

DAVID DOUBILET

Underwater photographer. Explorer. Artist.
Marine naturalist and protector of the ocean habitat.
Author of a dozen books on the sea.
For 50 years, his passion has illuminated
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The Namaz-e-Tawbah, a Muslim daily prayer of repentance, is recited by many in a country where Islam is the dominant faith. Nearly 90 percent of the population is Sunni, though not everyone is devout. Religion was not practiced openly until 1991, when Uzbekistan gained independence from the Soviet Union.



A woman rounds a corner in Andijon, where high walls hem streets and authorities strive to regulate religious practices and inhibit social unrest. In 2005 the city was the site of a massacre in which hundreds of unarmed protesters were shot and killed by government security forces.

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VISIONS OF EARTH



Romania Two young women stroll through Budești, chic heels and jackets augmenting traditional church attire. Such styles reflect a migratory trend: After working abroad, many here are carrying back money and modernity.

PHOTO: TIM DIRVEN, PANOS PICTURES



United States Like brushes saturated with paint, the wing scales of a sunset moth drip with color. Shot in a Washington State photo studio using a microscope, their iridescence is revealed only in this close-up view.

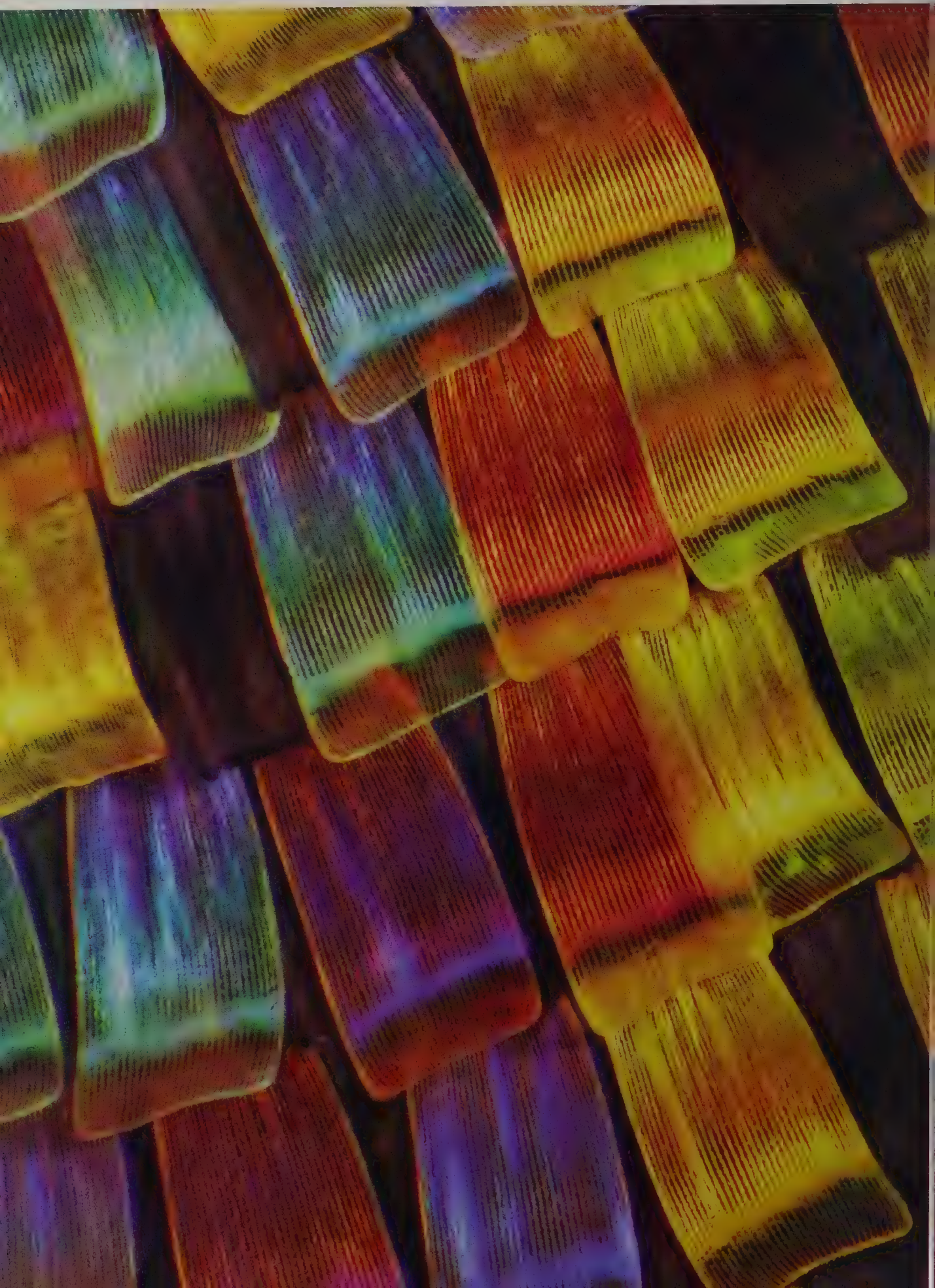


PHOTO: CHARLES KREBS

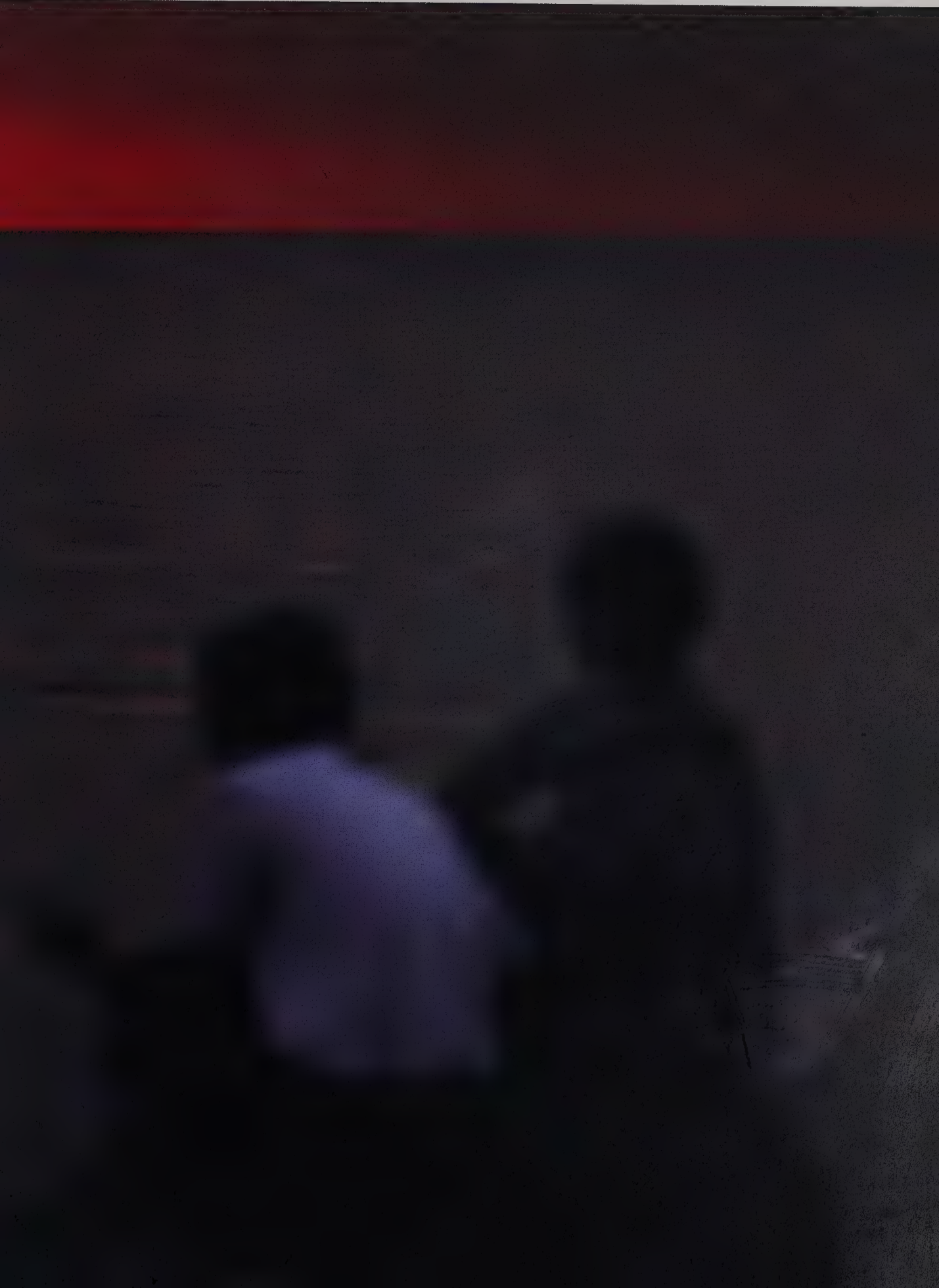


Philippines Children gaze at the storybook sight of a partial solar eclipse over Manila Bay. The result of a syzygy—an instance when the Earth, moon, and sun are aligned—it was visible on parts of four continents.

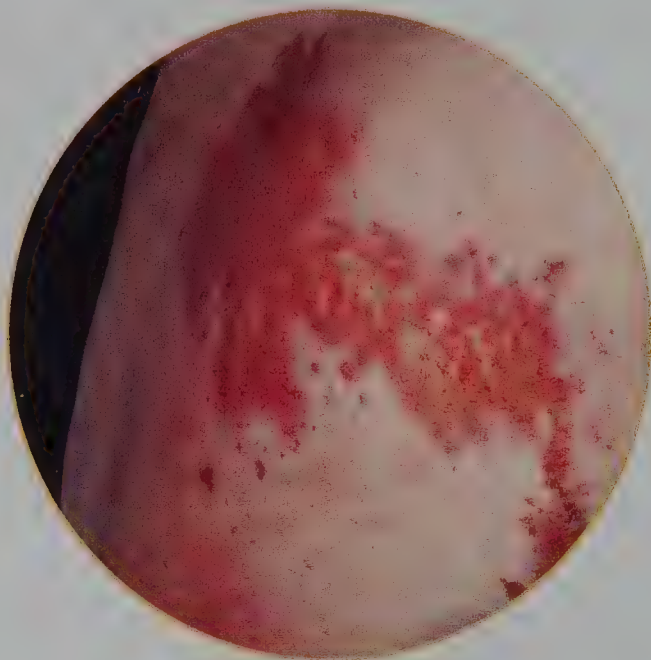


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PHOTO: GIL NARTEA, AFP/GETTY



**IMAGINE THIS BLISTERING RASH
ALONG WITH STABBING PAIN**



**AND YOU'LL HAVE AN IDEA OF
WHAT IT CAN BE LIKE TO HAVE SHINGLES.**



For more information on the availability of ZOSTAVAX through the Merck Vaccine Patient Assistance Program, visit www.merck.com/merckhelps or call 1-877-9 SHINGLES.

IF YOU HAD CHICKENPOX AS A CHILD, YOU COULD GET SHINGLES NOW.

The chickenpox virus is still in your body.

It can resurface as Shingles, a painful, blistering rash. The Shingles rash usually lasts up to 30 days, and for most the pain lessens as the rash heals. But some people who develop Shingles experience long-term pain that can last for months, even years.

ZOSTAVAX is a vaccine that can help prevent Shingles.

ZOSTAVAX is used to prevent Shingles in adults 60 years of age or older. Once you reach age 60, the sooner you get vaccinated, the better your chances of protecting yourself from Shingles. ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it. Talk to your health care professional to see if ZOSTAVAX is right for you.

Important Safety Information

ZOSTAVAX may not fully protect everyone who gets the vaccine. You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin and neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. Possible side effects include redness, pain, itching, swelling, warmth, or bruising at the injection site, as well as headache. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088. Before getting vaccinated, talk to your health care professional about situations you may need to avoid after getting ZOSTAVAX. Please see the Patient Product Information on the adjacent page.

Before you get Shingles, ask about ZOSTAVAX.

ZOSTAVAX[®]
Zoster Vaccine Live

www.zostavax.com

9815608

**Patient Information about
ZOSTAVAX® (pronounced "ZOS tah vax")
Generic name: Zoster Vaccine Live**

You should read this summary of information about ZOSTAVAX¹ before you are vaccinated. If you have any questions about ZOSTAVAX after reading this leaflet, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 60 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles. If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people.

ZOSTAVAX may not protect everyone who gets the vaccine. ZOSTAVAX cannot be used to treat shingles once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including nonprescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, warmth, or bruising where the shot was given.
- headache.

The following additional side effects have been reported in general use with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- fever
- hives at the injection site
- joint pain
- muscle pain
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

What else should I know about ZOSTAVAX?

Vaccinees and their health care providers are encouraged to call (800) 986-8999 to report any exposure to ZOSTAVAX during pregnancy.

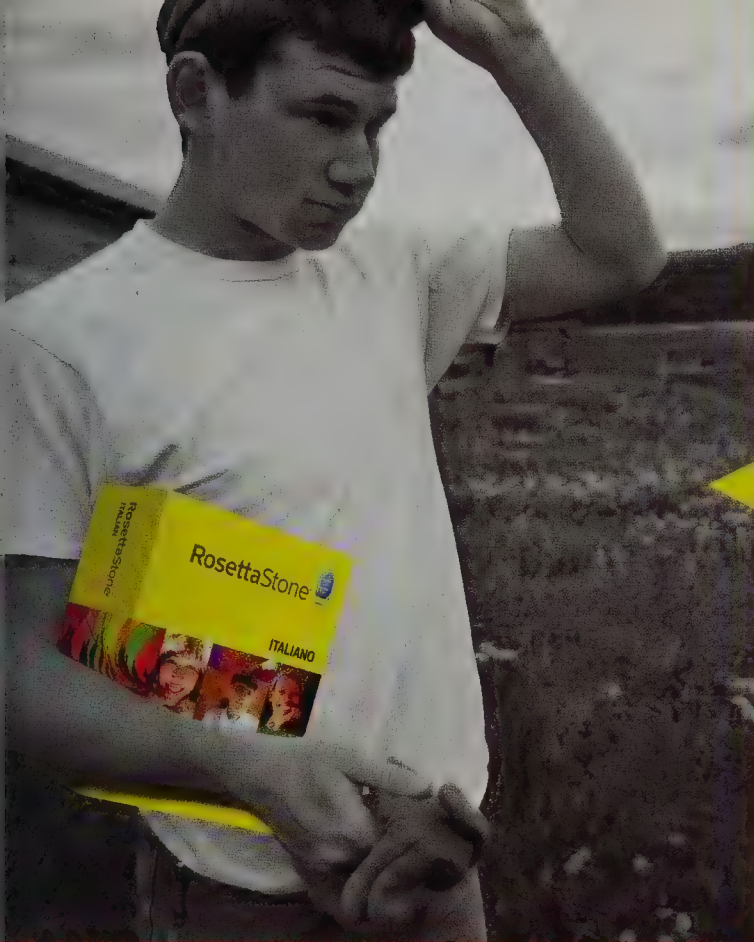
This leaflet summarizes important information about ZOSTAVAX.

If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

Rx only

Issued April 2009

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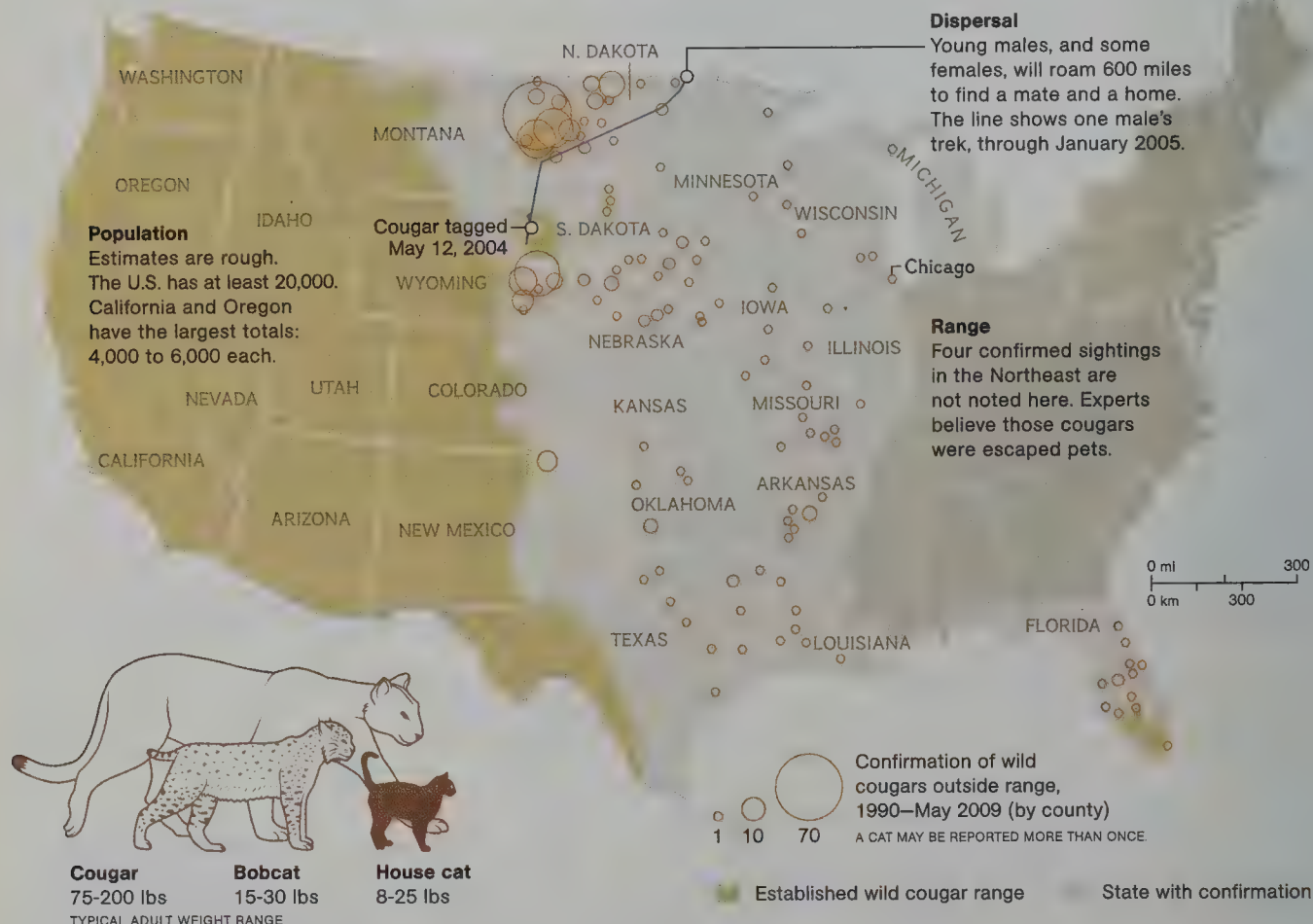
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Where the Cougars Are

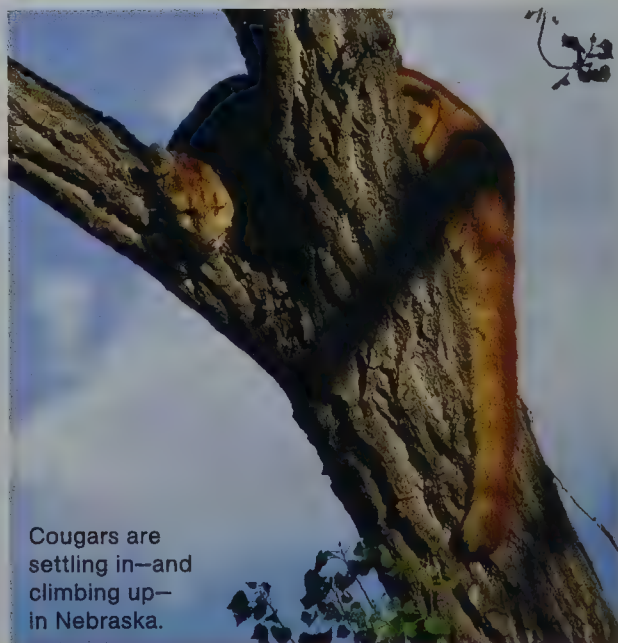
Hundreds of sightings are reported to the Cougar Network each year. Those below were confirmed by photo, carcass, or paw print.



Call them cougars, mountain lions, or pumas.

Americans think they see them everywhere. That's no surprise in the West; strict management helped the predatory cat make a remarkable recovery after "varmint hunters" took numbers very low by the mid-1900s. Eastbound cougars are also turning up in the Midwest. South Dakota has a breeding population of 200-plus; just last year, Chicago cops cornered and shot one on the North Side.

But Eastern sightings are suspect. Florida has 70 to 100 wild cougars, a remnant from the days when the cat covered the continent. Other folks likely glimpsed a bobcat or a darned big house cat. "Imaginations get carried away," says Clay Nielsen, wildlife ecologist at Southern Illinois University Carbondale. If you do meet a cougar—and really, the cat tries to avoid humans—experts say, Don't run! Otherwise, a 150-pound cat might mistake you for a deer dinner. —Marc Silver



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Lithium Rush Just as gas-powered autos depend on oil, the world's future fleet of electric cars may well depend on an obscure element now mined in only a handful of places: lithium. Because it is the world's lightest metal and good at holding a charge, lithium in batteries can deliver the energy electric cars need without weighing them down or requiring frequent recharging stops. Present in trace amounts throughout Earth's oceans and crust, lithium is amazingly versatile. It can run laptop computers, treat bipolar disorder (In powdered form, though



scientists don't know exactly how it prevents mood swings), and even give ceramics a brighter glaze.

Lithium is mined as an ore in rocks and as a mineral suspended in briny solutions found beneath salt flats. In recent years Chile has developed its lithium-rich salt flats to become the world's top producer. With rising demand, new deposits will have to be tapped—including an estimated 5.95 million tons beneath a high-altitude desert in Bolivia. —Karen E. Lange

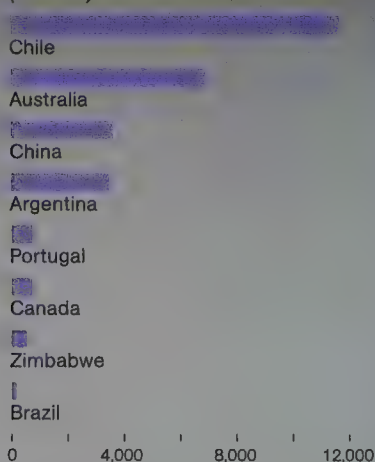
HOW IT WORKS

In a lithium-ion battery, lithium is the positive electrode, graphite the negative. Ions flit across the plastic, producing energy. Layers of copper hold it all together.

-  copper
-  lithium cobalt oxide
-  plastic
-  graphite
-  copper



LITHIUM MINE PRODUCTION, 2008
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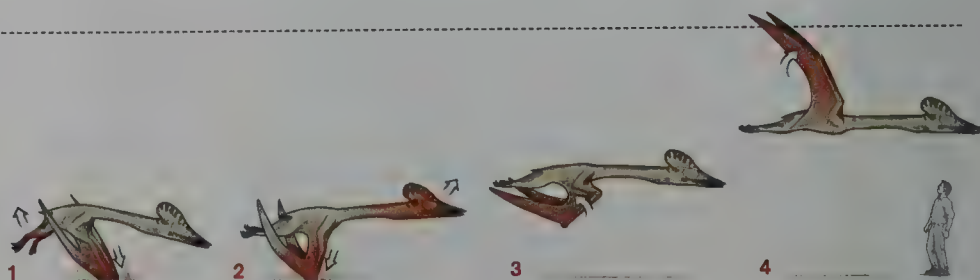
Tupuxuara, a type of pterosaur, lived 112 million years ago in present-day Brazil.

Pterosaur Takeoff They were weirdly shaped weaklings, giraffe-tall hang gliders forced to hurl themselves off cliffs to get airborne. At least that's the traditional view of the flying reptiles called pterosaurs, which went extinct along with dinosaurs some 65 million years ago. But a novel idea of pterosaur flight has caught the notice of paleontologists worldwide. According to Johns Hopkins doctoral student Michael Habib, these dragon-like creatures—the largest of which may

have weighed well over 500 pounds—had the power to take off from flat ground. Habib, who used to study bird flight, says pterosaurs' wing bones were too massive for them to have simply been frail gliders. But beefy wings make sense if they flew by first tipping forward off comparatively spindly back legs, then using their front limbs to explosively leapfrog into the air. If that theory takes wing, pterosaurs could gain a muscular new profile in Mesozoic history. —Chris Carroll

WINGING IT

A pterosaur leaned forward on its wings and, with a catapult-like action, hurtled off the ground. Once aloft, it flapped away, according to a new theory.



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†Tires must be purchased from a Bridgestone retailer's inventory between August 29 and September 26, 2009. Mail-in claim form required. Restrictions and limitations apply. See your participating Bridgestone retailer for complete details.



A 1959 Volvo in Sweden was the first car to feature a three-point seat belt.

Saved By the Belt Few inventors can claim credit for saving more than a million lives, but Nils Bohlin is one of them. Fifty years ago the Volvo engineer modified an airplane device and came up with the three-point seat belt—one strap across the hips, one across the chest, both anchored to the same point on the car floor.



It was a milestone advance in auto safety, especially in the car-crazy U.S., where it was rolled out in 1963. Yet manufacturers of the time worried that it would remind consumers that cars could be unsafe. Misled motorists saw it as a danger, a nuisance, or both. That attitude persisted for decades: In 1981 only 11 percent of American drivers were buckling up.

Now, however, thanks to state seat belt laws, the national “Click It or Ticket” campaign, and automated in-car reminders, U.S. usage is at 80 percent. Engineers, meanwhile, are developing and refining sci-fi safety technologies like collision-avoidance and drowsiness-monitoring systems. Experts say these ideas have promise, but Bohlin’s simple seat belt is a proven lifesaver. —Winona Dimeo-Ediger

MILESTONES IN U.S. CAR SAFETY

- 1899** Henry H. Bliss is the first pedestrian killed in a traffic accident when he is hit by a New York City taxi.
- 1901** Oldsmobile debuts the speedometer; Connecticut puts limits on auto speed (12 mph in cities, 15 mph outside them).
- 1920** Detroit installs a three-color stoplight.
- 1937** Chrysler unveils a safer dashboard and padded seat backs.
- 1949** A Nash model features lap belts.
- 1952** A “safety cushion,” the precursor to the modern air bag, is first conceived.
- 1963** Some Volvos include three-point belts in their front seats.
- 1966** Crash-test dummies are modified for car-safety tests (in time replacing cadavers, chimps, and hogs).
- 1968** Federal law requires all passenger cars to carry seat belts.
- 1974** An “inconvenienced” public persuades Congress to repeal a law ensuring cars can’t start until seat belts are buckled.
- 1984** New York is the first state to require the use of seat belts.
- 1995** All states but New Hampshire have broad seat belt laws.
- 1998** All autos must have dual front air bags.
- 2008** Automakers trot out alarm systems that rouse sleepy drivers.
- 2020** Volvo envisions an “injury-proof” car.



Coachella Valley Fringe-toed Lizard (*Uma inornata*)

Size: Head and body length, 7 - 12.4 cm (2.8 - 4.9 inches); tail, approx. the same

Weight: Approx. 20 g (0.7 oz) **Habitat:** Coachella Valley area of California, from sea level to elevations of about 1,600 feet **Surviving number:** Unknown; populations declining



Photographed by Jenny E. Ross

WILDLIFE AS CANON SEES IT

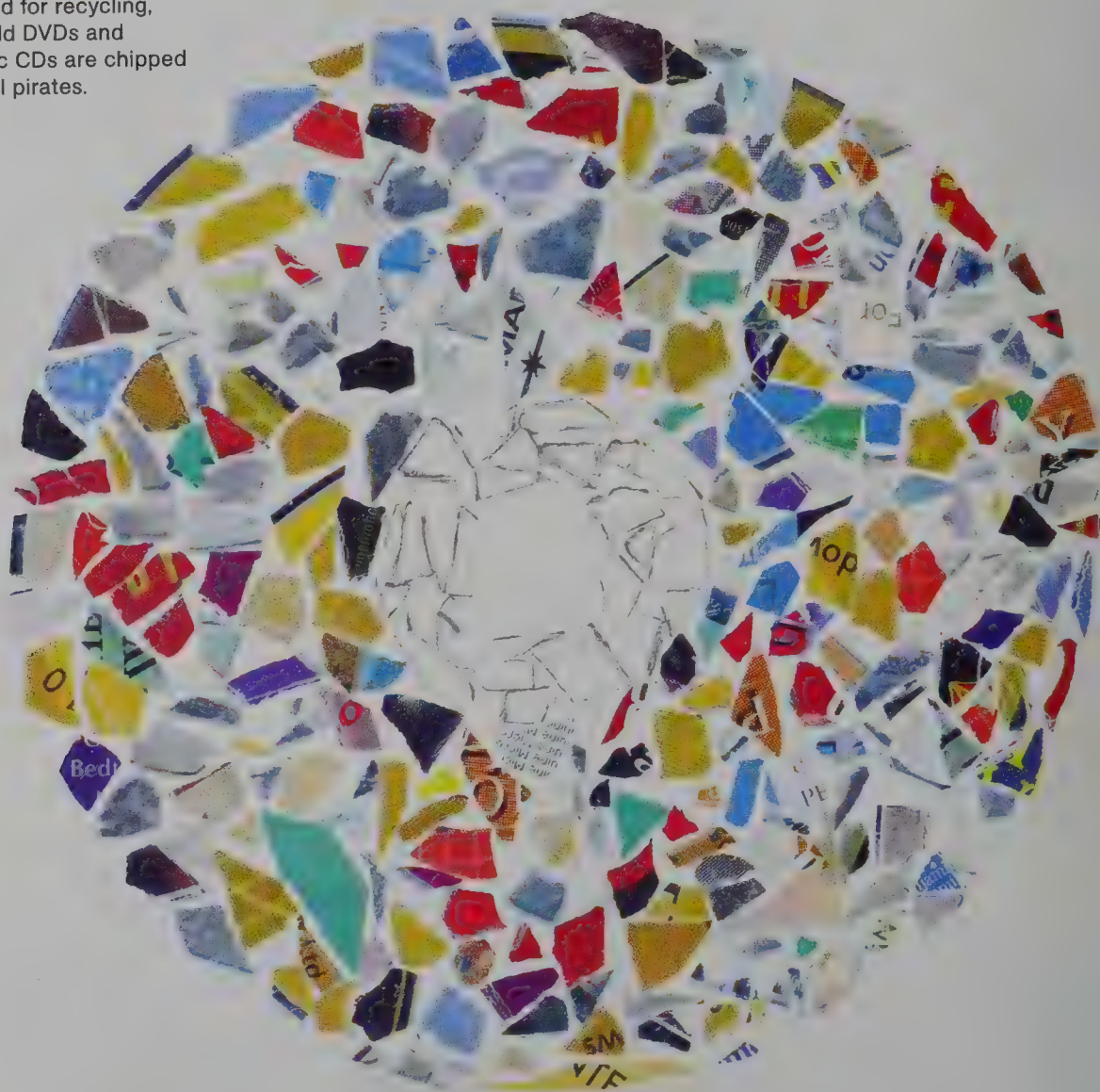
Sandy is just dandy. The Coachella Valley fringe-toed lizard is perfectly at ease with the fine, blowing sand and scorching heat of its California home. Its namesake fringed toes allow it to run quickly over sand without sinking, while its jaw, eyelids, ears and nostrils are all adapted to keep sand out. Active during the day, the dune dweller simply burrows into the sand for relief when the mercury rises to extremes. This is also an effective

strategy for avoiding predators. But the sand-wise lizard can't hide from habitat loss, which has been driven by development and the influx of exotic vegetation. Its precious sand is slipping away.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.

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Bound for recycling, unsold DVDs and music CDs are chipped to foil pirates.



Disc Demolition Count your damaged and unwanted CDs and DVDs. Multiply by millions of folks like you. Add in the business world's used data CDs and music, video game, and movie returns. The total is billions of trashed discs a year. How do you keep them out of the landfill?

Some recycling firms buy big batches of discs from businesses. The prize is the polycarbonate plastic covering the reflective data layer. Typically, a chemical bath removes ink, lacquer, and aluminum. The plastic is then melted and molded into eyeglass frames, car parts, and fences. Alas, says Darby Hoover of the Natural Resources Defense Council, the eco-impact of these steps is "hard to track"—especially at facilities in China.

Big-time recyclers aren't as interested in an individual's wee array of bum discs. San Francisco is one of the few American cities that picks up CDs curbside for recycling. If you don't mind paying postage, you can mail your discs to GreenDisk or the CD Recycling Center of America. If you do mind, be patient: Drop-off boxes are arriving at some chain stores.

Another option is to revive damaged discs. The Disc-Go-Devil device gets rid of scratches by buffing the plastic surface. Video-rental firms use the technology; stores may soon offer it. So, marred CDs and DVDs can live on until the day when all media is downloaded. By then there should be safe, convenient ways to recycle discs. —Marc Silver

There are 2 sources of cholesterol. Food & Family.



Only VYTORIN treats both.

It's important to eat healthy and stay active, but when that's not enough, talk to your doctor about treating the 2 sources of cholesterol with VYTORIN. VYTORIN contains two cholesterol medicines, *Zetia* (ezetimibe) and *Zocor* (simvastatin), in a single tablet.

VYTORIN is the only product that helps block cholesterol that comes from food and reduces the cholesterol your body makes naturally, based on family history. And VYTORIN can dramatically lower your bad cholesterol 45%–60%. (Average effect depending on dose; 52% at the usual starting dose.)

VYTORIN contains two cholesterol medicines, *Zetia* (ezetimibe) and *Zocor* (simvastatin), in a single tablet. **VYTORIN has not been shown to reduce heart attacks or strokes more than *Zocor* alone.**

Ask your doctor if VYTORIN is right for you. Or, to learn more, call 1-877-VYTORIN or visit vytorin.com.



To find out if you qualify, call 1-800-347-7503.

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MSP Singapore Company, LLC.

Important Risk Information About VYTORIN: VYTORIN is a prescription tablet and isn't right for everyone, including women who are nursing or pregnant or who may become pregnant, and anyone with liver problems.

Unexplained muscle pain or weakness could be a sign of a rare but serious side effect and should be reported to your doctor right away. VYTORIN may interact with other medicines or certain foods, increasing your risk of getting this serious side effect. So tell your doctor about any other medications you are taking.

Your doctor may do simple blood tests before and during treatment with VYTORIN to check for liver problems. Side effects included headache, muscle pain, and diarrhea. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

Please read the more detailed information about VYTORIN on the adjacent page.

VYTORIN[®]
(ezetimibe/simvastatin)

Treat the 2 sources of cholesterol.

VYTORIN® (EZETIMIBE/SIMVASTATIN) TABLETS **PATIENT INFORMATION ABOUT VYTORIN (VI-tor-in)**

Generic name: ezetimibe/simvastatin tablets

Read this information carefully before you start taking VYTORIN. Review this information each time you refill your prescription for VYTORIN as there may be new information. This information does not take the place of talking with your doctor about your medical condition or your treatment. If you have any questions about VYTORIN, ask your doctor. Only your doctor can determine if VYTORIN is right for you.

WHAT IS VYTORIN?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. VYTORIN is for patients who cannot control their cholesterol levels by diet and exercise alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight. VYTORIN has not been shown to reduce heart attacks or strokes more than simvastatin alone.

WHO SHOULD NOT TAKE VYTORIN?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For a list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.
- If you are a woman of childbearing age, you should use an effective method of birth control to prevent pregnancy while using VYTORIN.

VYTORIN has not been studied in children under 10 years of age.

WHAT SHOULD I TELL MY DOCTOR BEFORE AND WHILE TAKING VYTORIN?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle breakdown resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine
- danazol
- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin, clarithromycin, and telithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥ 1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN® (ezetimibe/simvastatin) may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

HOW SHOULD I TAKE VYTORIN?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

WHAT SHOULD I DO IN CASE OF AN OVERDOSE?

Contact your doctor immediately.

WHAT ARE THE POSSIBLE SIDE EFFECTS OF VYTORIN?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache, muscle pain, and diarrhea (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with VYTORIN or with ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), rash, hives; raised red rash, sometimes with target-shaped lesions; joint pain; muscle pain; alterations in some laboratory blood tests; liver problems (sometimes serious); inflammation of the pancreas; nausea; dizziness; tingling sensation; depression; gallstones; inflammation of the gallbladder; trouble sleeping; poor memory.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is not a complete list of side effects. For a complete list, ask your doctor or pharmacist.

GENERAL INFORMATION ABOUT VYTORIN

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: vytorin.com.

Inactive ingredients:

Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hypromellose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

Issued May 2009



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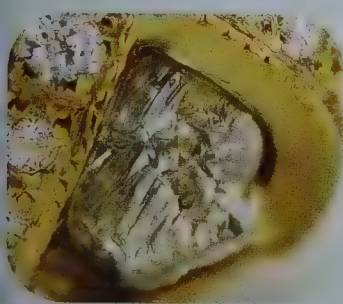
Perfect imperfection, the natural raw 2 carat diamond

**Ready for some rough stuff?
We recently found a rare cache of
extremely large uncut diamonds at
an extraordinary price.**

Sometimes it's impossible to improve on perfection. When the world's most desired stone is pulled from the ground, why not just brush off the earth and leave it alone? White cut diamonds may be nice for a polite kiss on the cheek, but extra large uncut diamonds can really ignite some raw passion. And isn't that what a great piece of jewelry is all about? These few rare 2 carat plus natural stones will certainly turn up your thermostat.

A real diamond in the rough

For centuries, large raw diamonds were treasured without a hint of facet or polish. We believe the early artisans were on to something. After a search through countries on four continents, we have found a cache of rare, very large, 2 carat plus uncut diamonds at a



Similar rough diamonds sell elsewhere for thousands! Please compare the size and price of our raw diamond in the Stauer Raw Diamond Necklace with those at your local jewelry store.

spectacular price from our Belgium dealer. Major gemstone experts across the globe have commented that rough diamonds will be the fastest growing trend on "the red carpet" this year and our long love affair with flawless cut white gemstones may have some competition. All one has to do is flip through the

world's most exclusive catalog to find that "rough is all the rage." Our luxury retail friends in Texas recently featured a raw solitaire for \$6,000, but they buy in such small quantities that they cannot compete with us on price. You see, Stauer is one of the largest gemstone buyers in the world and last year bought over 3 million carats of emeralds. No regular jewelry store can come anywhere close to that volume.

Equal parts "rough" and "refined"

Our **Raw Diamond Necklace** is a balanced blend of



geology and geometry. Each one-of-a-kind raw diamond is fitted by hand into its "cage," a crisscross embrace of gold vermeil over the finest .925 sterling silver, bead-set with 18 round diamonds. The caged diamond hangs from a triangular bail with an additional 8 diamonds (26 total). The pendant is suspended from an 18" gold vermeil rope chain with spring ring clasp. Each raw diamond is naturally unique. This is an extremely limited edition since it took us 3 years to find this small cache of stones.

Show off your Stauer **Raw Diamond Necklace** for 30 days. If you're not feeling the rush of raw, large diamonds, simply return it for a full refund of your purchase price. But if you feel like experiencing the unique perfection of natural uncut beauty, you have found the way.

Keep in mind that each raw diamond is completely different. The shape, shine and color will vary. But your caged Raw Diamond Necklace will forever remain a reminder of the unspoiled, organic beauty of nature.

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Facing Beggars In a downturn, begging goes on an upswing. “You do see more of it,” says Roughan MacNamara of Focus Ireland, which aids the homeless. A typical government response is to crack down. Ireland, for instance, is rewriting 1847 anti-vagrancy laws so that police officers can round up “aggressive” beggars, deemed a threat to pedestrians, businesses, and tourism.

Anti-begging laws are gaining popularity in North America as well, says University of Toronto criminologist Joe Hermer. But his research suggests that police initially enforce such laws, then inevitably turn to other issues—and beggars return to the streets.

Another tactic to reduce begging is “diverted giving.” There’s a common perception that beggars use handouts for drugs and booze. So in cities like Baltimore and Denver, folks can drop coins in converted parking meters; the money goes to homeless charities. But beggars aren’t all substance abusers. In a seminal 2001 U.K. survey, 45 percent cited food as their main purchase; 37 percent said drugs.

Meanwhile, parking-meter altruism doesn’t help everyone figure out how to react to a lonely, outstretched hand. “Sometimes I give, sometimes I don’t,” admits Ed Shurna, a Chicago advocate for the homeless. “But my philosophy is that I always say hello.” —Marc Silver

BEGGING LAWS

Here are some methods used to reduce begging.

■ **Ireland** A new law targets beggars who threaten violence, beg repeatedly in one place, or use children as props.

■ **India** Motorists can be fined if they give to beggars at traffic lights.

■ **United States** Denver’s “sit and lie” law says people can’t block sidewalks. The police give warnings; outreach workers offer help. Arrests are a last resort.



Panhandlers, like this one in New York City, are a small but highly visible segment of the homeless.



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IN THE WOODS
THAT THE WOODS ARE STILL
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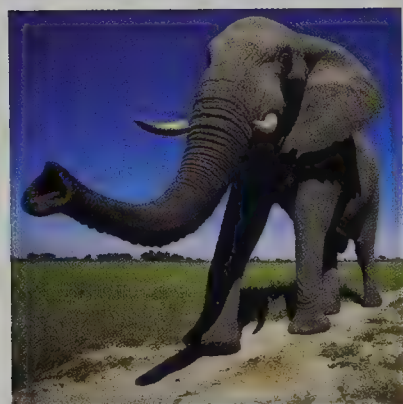
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Who's Number Two?

Most folks know the cheetah's top speed of 70 mph makes it the fastest land animal. But what's the runner-up? Turns out it's the pronghorn. The deerlike mammal cruises at 35 mph and can hit 50. Its velocity is thought to have been a defense against cheetahs that lived in North America eons ago. Often overlooked, number twos can show how close the race is—or how far ahead a number one really is. —Melody Kramer



Second tallest animal African elephant (#1: Giraffe)

The heaviest land mammal is the second tallest. Males grow to about 12 feet, females hit 9 feet. But at 15 to 19 feet tall, a grown giraffe could eat beans off an elephant's head.

Second tallest structure KVLV TV mast, North Dakota (#1: Burj Dubai building, 2,320 feet now; 2,600 is the goal)

The 2,063-foot-tall transmitting tower was completed in 1963. The FCC now suggests topping towers off at 2,000 feet for aircraft safety.

Second highest point on Earth K2 (#1: Everest, 29,035 feet)

Dubbed Savage Mountain, the 28,251-foot K2 is one of the deadliest for climbers, with 77 fatalities.

Second deepest spot on Earth Tonga Trench (#1: Mariana Trench)

In the duel of Pacific depressions, 35,837-foot Tonga is 400 feet shallower. It is the only trench holding a generator jettisoned by Apollo 13.

Second largest metropolitan area New York City-Newark, 19.04 million (#1: Tokyo, 36 million)

Look out, Big Apple. By 2025, you'll probably be trailing Mumbai, Delhi, São Paulo, Dhaka, and Mexico City.

Second least populous state Tuvalu, 12,177 citizens (#1: Vatican City, 824)

The Pacific island nation is just a sixth the size of Washington, D.C.

Second most popular tourist destination Spain, 59.2 million visitors in 2007 (#1: France, 81.9 million)

Second most widely spoken language as a first language Hindi, 366 million (#1: Mandarin Chinese, 873 million)

Second closest living human relative Gorilla (#1: Chimpanzee)

Humans and chimps split from a common ancestor about seven million years ago. Gorillas and humans split some three million years before that.



Second smallest planet Mars (#1: Mercury)

The red planet was bumped from #3 to #2 after astronomers stripped Pluto, previously the solar system runt, of planetary status.



Second hardest gemstone Ruby/sapphire (#1: Diamond)

Rubies and sapphires are variations of the mineral corundum, which is also used in sandpaper.

Second longest river Amazon (#1: Nile)

Or is it the other way round? The debate goes on. Traditional stats: Nile, 4,241 miles; Amazon, 4,000.



Second longest fish Basking shark (#1: Whale shark)

It can reach 30 feet; a whale shark can grow to 40 to 60 feet.

Second shortest fish Stout infantfish (#1: Adult male spiny-headed devilfish, .24 inch)

A mature stout infantfish is .27 inch. But even runners-up can prevail. Till other wee fry are weighed, the infantfish is the lightest fish: 500,000 to a pound.



THE LAWS OF GRAVITY DON'T APPLY TO EUPHORIA.

*My leash is broken. Nothing can keep me down.
I can't find that kind of fun anywhere else.
There's an air of freedom here.*



*...perfect for me.
...beaten path with everything
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The four-foot-tall muskox's stumpy legs and shaggy hair can make maneuvering difficult in deep snow.



Muskox range

■ Native ■ Introduced

NG GRANT Where Muskoxen Roam The muskox may look otherworldly, but it's very much a creature of the Earth. In fact, this 800-pound primal relative of sheep and goats has roamed the Arctic for about a million years, since the Pleistocene. Scientists want to make sure it stays around for a long time to come.

Some conservationists fear that certain muskox populations, particularly in the southern ranges (see map), could be imperiled by climate change. Wet winters can spell trouble if deep snow and ice restrict access to food. Warm autumns can mean disease or inhospitable habitat. All this can cause problems with reproduction.

In Alaska, where the native species died out in the 19th century, reintroduction has been mostly successful. Some 4,300 of the world's 150,000 muskoxen now live there. But in the Arctic National Wildlife Refuge, numbers have plunged by 50 percent in the past decade. Wildlife Conservation Society biologist and NG grantee Joel Berger has begun tracking Alaska muskoxen with GPS collars to see where else they may be vulnerable, and why. He says room to roam is one key to their survival, so that they can continue to leave areas that don't sustain them. In other words, more open space could buy these Ice Age survivors more time. —Hannah Bloch



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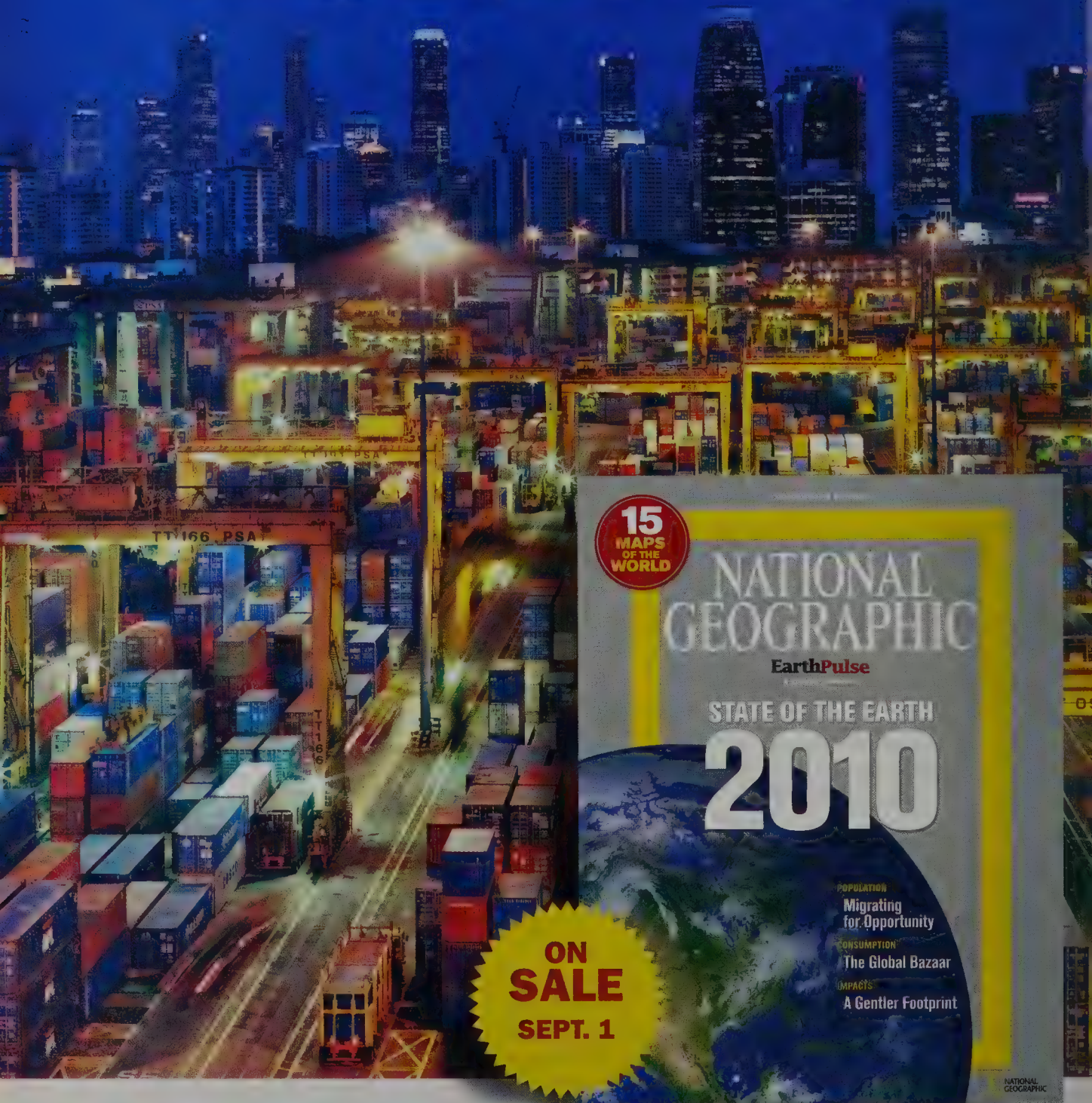
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SPECIAL COLLECTOR'S EDITION

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Time travel at the speed of a 1935 Speedster?

The 1930s brought unprecedented innovation in machine-age technology and materials. Industrial designers from the auto industry translated the principles of aerodynamics and streamlining into everyday objects like radios and toasters. It was also a decade when an unequalled variety of watch cases and movements came into being. In lieu of hands to tell time, one such complication, called a jumping mechanism, utilized numerals on a disc viewed through a window. With its striking resemblance to the dashboard gauges and radio dials of the decade, the jump hour watch was indeed "in tune" with the times!

The Stauer 1930s Dashtronic deftly blends the modern functionality of a 21-jewel automatic movement and 3-ATM water resistance with



True to Machine Art esthetics, the sleek brushed stainless steel case is clear on the back, allowing a peek at the inner workings.

the distinctive, retro look of a jumping display (not an actual jumping complication). The stainless steel 1 1/2" case is complemented with a black alligator-embossed leather band. The band is 9 1/2" long and will fit a 7-8 1/2" wrist.

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From Africa to Astoria by way of everywhere

DNA from a single New York melting pot records the prehistoric migrations that peopled the planet.

FORKING PATHS through prehistory—and branches of the human family tree—are revealed by DNA mutations in 193 volunteers sampled in Astoria, Queens. Mutations known to have arisen in certain times and regions act as wayside markers tracing at least some of a participant's ancient geographic heritage. Four participants are highlighted here; the Queens group as a whole is representative of most, but not all, of the paths our prehistoric ancestors followed as they migrated out of Africa.



120,000 years ago

| 100,000

80,000

60,000

East Africa

Pedro Aguilar

Dotted lines represent the genetic histories of the four highlighted volunteers (photographs, far right).

Alma Mujezinovic

Atsushi Mizukami

Michelle Brown-Johnston

Colors represent regions; branch thickness indicates how many of the 193 volunteers had ancestors from each region.

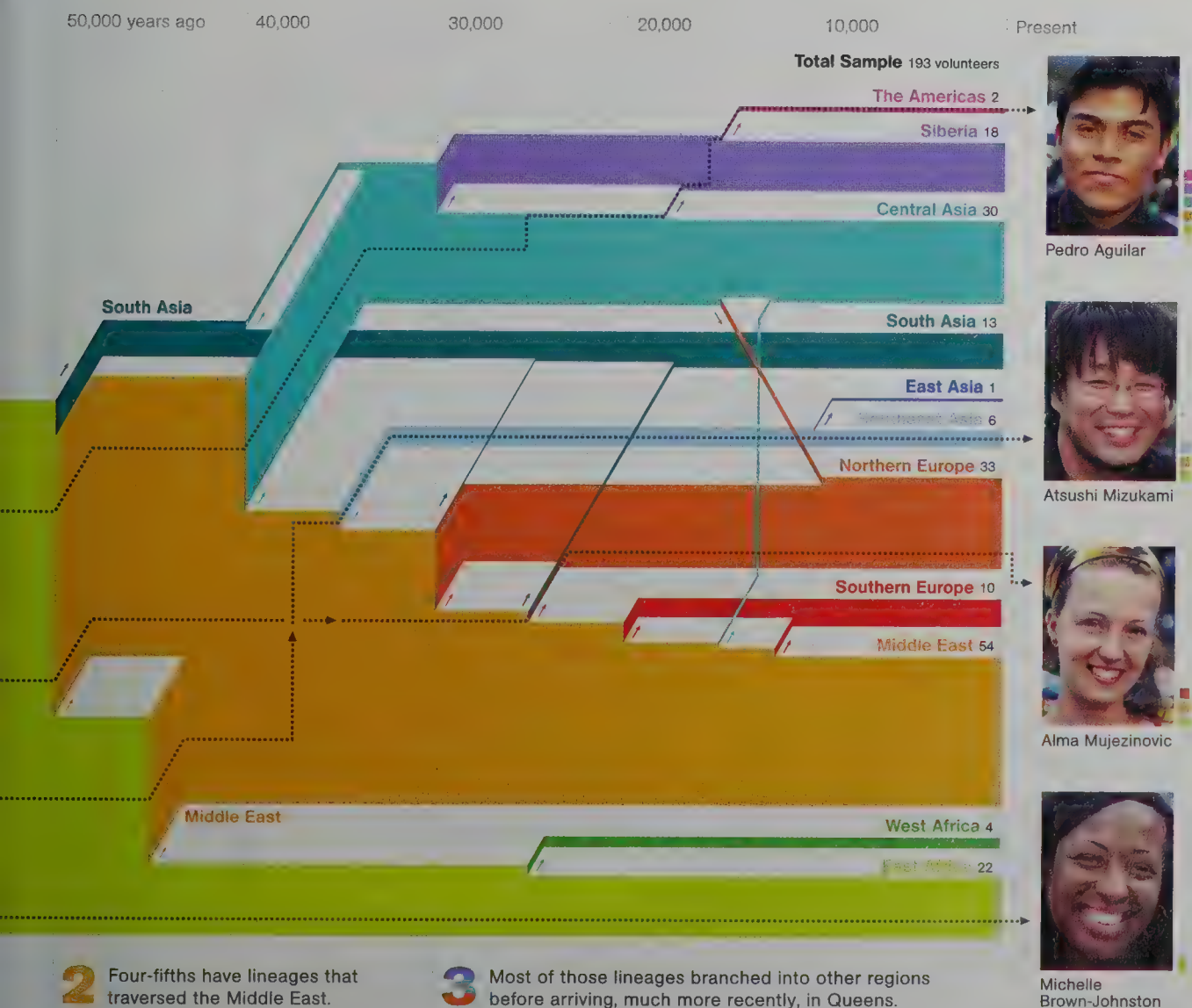
1 All the participants in Queens, like the rest of us, can trace their earliest ancestors to East Africa—the green trunk of the human family tree.

The Astoria section of Queens, New York, is one of the most ethnically diverse communities on Earth. At the 30th Avenue Street Festival in July 2008, people of all heritages and complexions mingled among booths offering up Thai charms and Peruvian sweaters, Mexican corn and Italian zeppole. The sun was hot, the mood merrily multicultural. Through the crowd walked a tall, blond man with pale skin rapidly turning red. He stopped occasionally to talk to people, and if he found them obliging, asked if they could spare a few cells from the inside of their cheeks.

For the past four years Spencer Wells and his colleagues with National Geographic and IBM's Genographic Project have been traveling

the globe, collecting DNA in cheek swabs and blood samples from hundreds of indigenous groups. By comparing their DNA, the project has been retracing the ancient history of human migrations since our species originated in Africa some 200,000 years ago.

The Genographic Project focuses on the Y chromosome in males, which is handed down intact from father to son, and on mitochondrial DNA (mtDNA), which a mother passes to her offspring. Over generations, small, harmless mutations accumulate on these two snippets of DNA; to Wells and other scientists these genetic markers constitute a history book. As ancient human populations migrated out of Africa,



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THE HUMAN JOURNEY

From global DNA data, Genographic and other scientists have charted the spread of humankind out of East Africa. The dates here represent the first arrivals in a region.



splitting off from each other and entering new lands, they accumulated different patterns of markers that reflect that history. Each individual today retains such a pattern.

In recent centuries those prehistoric paths have reconnected in New York and other immigrant havens. "From the beginning of the project," Wells says, "I've wondered if it would be possible to sample all the major lineages on Earth on a single street." On 30th Avenue he almost did—the 193 volunteers turned out to be carrying genetic markers for virtually all the

major migrations that peopled the continents. The only missing lineage was the oldest one, which Genographic scientists found in Khoisan hunter-gatherers in southern Africa; their ancestors initially diverged from other modern humans more than 100,000 years ago.

The DNA of small, relatively unmixed groups like the Khoisan still preserves clear signals of their unique population histories. In places like Queens, where people from around the world have been swapping DNA for generations, those histories are being lost; a Y chromosome, say, doesn't reflect the whole ancestry of its owner, let alone of a population. If the Genographic Project usually targets populations that have so far escaped the melting pots, it's precisely because those pots are such a rich confusion of genes.

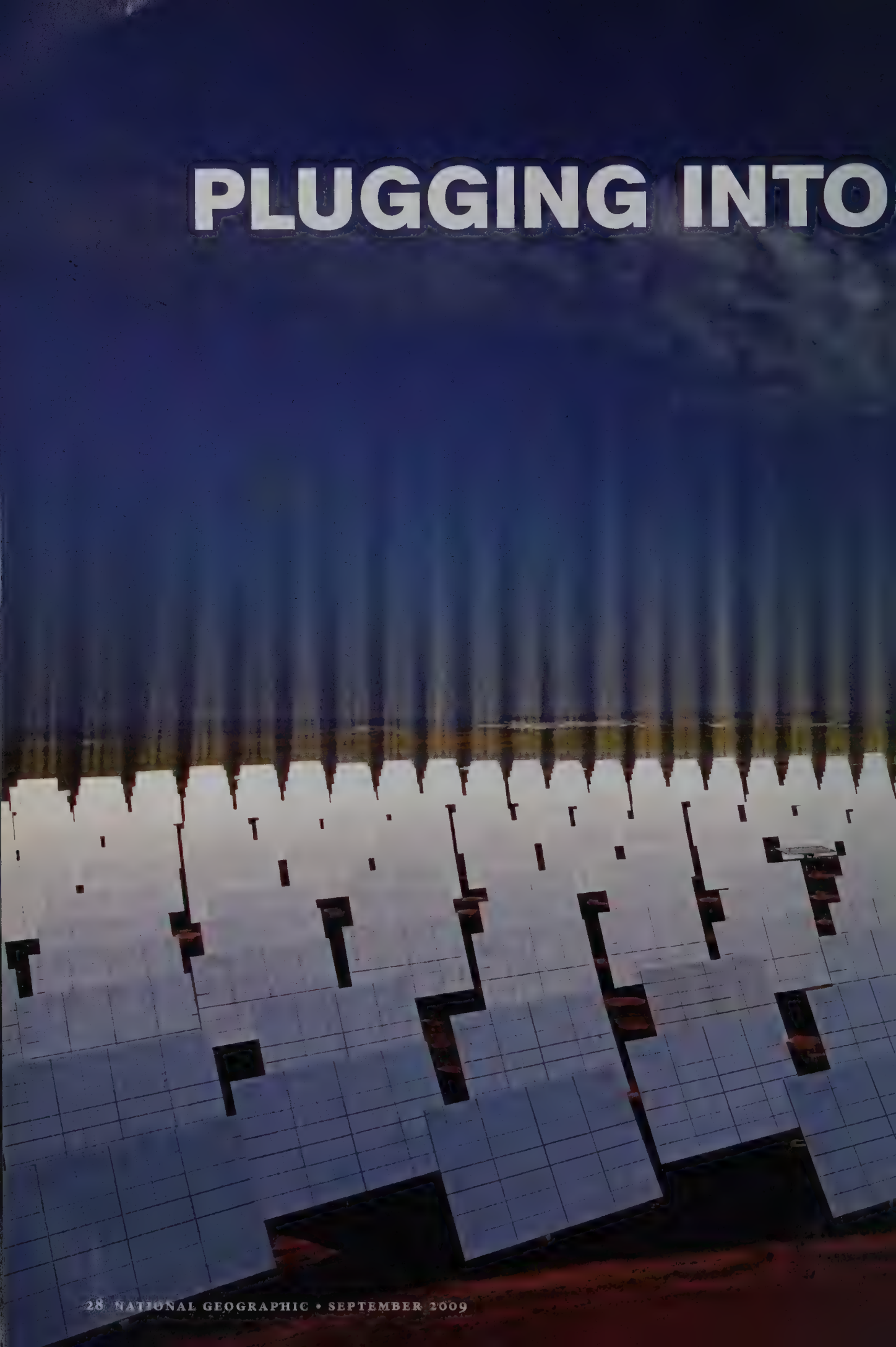
"Everybody talks about Astoria like its Greek," says George Delis, a retired community manager and a Greek immigrant himself. "Well, it's not Greek. It's everything." —Jamie Shreeve



Alisea Parikh

To learn more about human migrations and the Genographic Project, watch *The Human Family Tree* on the National Geographic Channel, August 30 at 9 p.m. ET in the U.S. Or click on the globe at ngm.com/genographic.

PLUGGING INTO

A large-scale solar farm is shown from a low angle, looking down the rows of solar panels. The panels are tilted and reflect the bright sky and the surrounding landscape. In the background, a body of water is visible, reflecting the sky and the solar panels. The overall scene is a mix of blue, white, and brown tones.

THE SUN

**SUNLIGHT BATHES US IN FAR MORE ENERGY THAN WE
COULD EVER NEED—IF WE COULD JUST CATCH ENOUGH.**



At an electric plant in southern Spain, mirrors as big as houses catch some of the 120 quadrillion watts of sunlight that constantly fall on Earth. Government subsidies for this pricey yet promising power source have made Europe the world's solar capital.



Turning unused space into a power source for 1,300 homes, Southern California Edison contractors cover a 14-acre warehouse roof near Los Angeles with some 33,000 lightweight photovoltaic, or PV, panels. California law requires utilities to generate 20 percent of their power from renewable sources by 2010.



BY GEORGE JOHNSON

PHOTOGRAPHS BY MICHAEL MELFORD

F

Early on a clear November morning in the Mojave Desert, the sun is barely touching the peaks of the McCullough Range with a cool pink glow. Behind them, a full moon is sinking over the gigawatt glare of Las Vegas. Nevada Solar One is sleeping. But the day's work is about to begin.

It is hard to imagine that a power plant could be so beautiful: 250 acres of gently curved mirrors lined up in long troughs like canals of light. Parked facing the ground overnight, they are starting to awaken—more than 182,000 of them—and follow the sun.

"Looks like this will be a 700-degree day," says one of the operators in the control room. His job is to monitor the rows of parabolically shaped mirrors as they concentrate sunlight on long steel pipes filled with circulating oil, heating it as high as 750 degrees Fahrenheit. From the mirror field, the blistering liquid pours into giant radiators that extract the heat and boil water into steam. The steam drives a turbine and dynamo, pushing as much as 64 megawatts onto the grid—enough to electrify 14,000 households or a few Las Vegas casinos. "Once the system makes steam, it's very traditional—industry-standard stuff," says plant manager Robert Cable, pointing toward a gas-fired power plant on the other side of Eldorado Valley Drive. "We get the same tools and the same parts as the place across the street."

When Nevada Solar One came on line in 2007, it was the first large solar plant to be built in the United States in more than 17 years. During that time, solar technology blossomed elsewhere. Nevada Solar One belongs to Acciona, a Spanish company that generates electricity here and sells it to NV Energy, the regional utility. The mirrors were made in Germany.

Putting on hard hats and dark glasses, Cable and I get into his pickup and drive slowly past row after row of mirrors. Men with a water truck are hosing down some. "Any kind of dust affects them,"

As the lights come on in Los Angeles, solar evangelist Larry Kazmerski models the latest in PV: bendy thin-film panels that fit so many places, says the National Renewable Energy Laboratory researcher, they could one day power whole cities. "This is going to be on every roof and building," Kazmerski says.

George Johnson is the author of The Ten Most Beautiful Experiments and seven other books. Michael Melford is a regular contributor; his photos on Herod the Great appeared in the December 2008 issue.



The optimists say solar power could become as economical and efficient as fossil fuels. The pessimists say they've heard all this before.

Cable says. At the far edge of the mirror field, we stop and step out of the truck for a closer look. To show how sturdy the glass is, Cable bangs it like a drum. Above his head, at the focal point of the parabola, the pipe carrying the oil is coated with black ceramic to soak up the light, and it's encased in an airless glass cylinder for insulation. On a clear summer day with the sun directly overhead, Nevada Solar One can convert about 21 percent of the sun's rays into electricity. Gas plants are more efficient, but this fuel is free. And it doesn't emit planet-warming carbon dioxide.

About every 30 seconds there is a soft buzz as a motor moves the mirrors a little higher; by midday they will be looking straight up. It's so quiet out here one can hardly fathom how much work is being done: Each of the 760 arrays of mirrors can produce about 84,000 watts—almost 113 horsepower. By 8 a.m. the oil coursing through the pipes has reached operating temperature. A white plume is spewing from a cooling stack. Half an hour later, the sound of the turbine inside the generating station has reached a high-pitched scream. Nevada Solar One is ready to go on line.

WITH A NEW ADMINISTRATION in Washington promising to take on global warming and loosen the grip of foreign oil, solar energy finally may be coming of age. Last year oil prices spiked to more than \$140 a barrel before plunging along with the economy—a reminder of the dangers of tying the future to something as unpredictable as oil. Washington, confronting the worst recession since the 1930s, is underwriting massive projects to overhaul the country's infrastructure, including its energy supply. In his inaugural address President Barack Obama promised to “harness the sun and the winds and the soil to fuel our cars and run our factories.” His 2010 budget called for doubling the country's renewable energy capacity in three years. Wind turbines and biofuels will be important contributors. But no form of energy is more abundant than the sun.

“If we talk about geothermal or wind, all these other sources of renewable energy are limited in their quantity,” Eicke Weber, director of the Fraunhofer Institute for Solar Energy Systems, in Freiburg, Germany, told me last fall. “The total power needs of the humans on Earth is approximately 16 terawatts,” he said. (A terawatt is a trillion watts.) “In the year 2020 it is expected to grow to 20 terawatts. The sunshine on the solid part of the Earth is 120,000 terawatts. From this perspective, energy from the sun is virtually unlimited.”

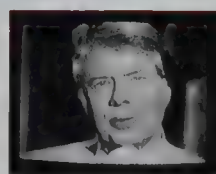
There are two main ways to harness it. The first is to produce steam, either with parabolic troughs like the ones in Nevada or with a field of flat, computer-guided mirrors, called heliostats, that focus sunlight on a receiver on top of an enormous “power tower.” The second way is to convert sunlight directly into electricity with photovoltaic (PV) panels made of semiconductors such as silicon.

Each approach has its advantages. Right now steam generation,



also known as concentrating solar or solar thermal, is more efficient than photovoltaic—a greater percentage of incoming sunlight is converted into electricity. But it requires acres of land and long transmission lines to bring the power to market. Photovoltaic panels can be placed on rooftops at the point where the power is needed. Both energy sources share an obvious drawback: They fade when it's cloudy and disappear at night. But engineers are already developing systems for storing the energy for use in the darker hours.

The optimists say that with steady, incremental improvements—no huge breakthroughs are required—and with substantial government support, solar power could become as economical and efficient as fossil fuels. The pessimists say they've heard all this before—30 years ago, during the presidency of Jimmy Carter. That too was a period of national crisis, triggered by the Arab oil embargo of 1973. Addressing the nation in his cardigan sweater, President Carter called for a new national energy policy with solar energy playing a large part. In 1979 the Islamic revolution in Iran sent oil prices soaring again. American drivers lined up for gasoline, their radios blaring songs like “Bomb Iran,” by Vince Vance and the



RETRO SOLAR The energy of the future has a past. Shards of old mirrors (top) lie under their replacements at California's 25-year-old SEGS I, the first commercial solar thermal plant in the United States. A 1977 speech by President Jimmy Carter (above) heralded the first federal push for renewable energy. But it faltered after Carter left office and oil prices later plummeted.

SunCatchers at Sandia National Laboratories in New Mexico stand dormant at moonrise. At daybreak each mirror array will turn sunward, and concentrated light will heat a Stirling engine held at the focal point, driving pistons and making electricity. No system is more efficient at converting photons to grid-ready AC power. Stirling Energy Systems plans to erect some 60,000 SunCatchers at desert sites near Los Angeles and San Diego.





If photovoltaic panels covered just three-tenths of a percent of the United States, a 100-by-100-mile square, they could power the entire country.

Valiants (sung to the tune of the Beach Boys' "Barbara Ann"). Carter, true to his word, put solar water heaters on the White House roof.

During the next few years, two large fields of parabolic troughs, SEGS I and II (for Solar Electric Generating Station) were installed about 160 miles southwest of Las Vegas, near Daggett, California. They were followed by seven more plants nearby, at Kramer Junction and beside waterless Harper Lake. The plants are still operating—about a million mirrors in all on some 1,600 acres with a combined power of 354 megawatts. From afar they look like mirages.

The momentum didn't last. As the economy adjusted to the Iranian oil shock, fuel prices fell. With the sense of urgency reduced, along with the research dollars, solar remained a minor factor in the energy equation. The SEGS plants were still being built when President Ronald Reagan took the solar water heaters off the White House roof. The first solar revolution fizzled.

Two decades later, a new solar revolution may be ready to begin.

ANOTHER LEGACY OF THE CARTER ERA, the National Renewable Energy Laboratory (NREL) in Golden, Colorado—the government's primary research center for solar, wind, hydrogen, and other alternative fuels—is bracing for a resurgence. When I visited last fall, a new research campus and headquarters were under construction against the side of a mountain outside Golden. Five acres of photovoltaic panels on top of the mesa will feed the labs and offices below. That may be just the beginning. Once treated by the government as something of a stepchild, NREL is benefiting from the extra money the Obama Administration is devoting to renewable energy. "Right now solar is such a small fraction of U.S. electricity production that it's measured in tenths of a percent," said Robert Hawsey, an associate director of the lab. "But that's expected to grow. Ten to 20 percent of the nation's peak electricity demand could be provided by solar energy by 2030."

But not without government help (see story, page 52). Nevada Solar One would never have been built if the state had not set a deadline requiring utilities to generate 20 percent of their power from renewable sources by 2015. (More than two dozen states now have "renewable-portfolio standards," and earlier this year Congress was debating a federal one.) During peak demand—a hot afternoon in Las Vegas, when production costs are highest—the solar plant's electricity is almost as cheap as that of its gas-fired neighbor. But that's only because a 30 percent federal tax credit helped offset its construction costs.

Aiming to bring down costs and reduce the need for incentives, NREL's engineers are studying mirrors made from lightweight polymers instead of glass and receiving tubes that will absorb more sunlight and lose less heat. They're also working on solar power's biggest problem: how to store some of the heat produced during daylight

hours for release later on. “In the Southwest particularly, peak loads are in the daytime, but they don’t end when the sun goes down,” said Mark Mehos, an NREL program manager. People come home from work, turn on lights and air conditioners. Before long they may be plugging in electric cars.

Last year the first commercial solar plant with heat storage opened near Guadix, Spain, east of Granada. During the day, sunlight from a mirror field is used to heat molten salt. In the evening, as the salt cools, it gives back heat to make more steam. In Arizona the Solana Generating Station will also use molten salt for storage. When it goes on line in 2012, three square miles of parabolic troughs will produce 280 megawatts for Phoenix and Tucson. Solana is being built by a Spanish company, Abengoa Solar—an indication of just how far, in the development of this technology, the United States has fallen behind.

BACK IN THE 1980s, an engineer named Roland Hulstrom calculated that if photovoltaic panels—the other big solar technology—covered just three-tenths of a percent of the United States, a 100-by-100-mile square, they could electrify the entire country.

People thought he wanted to pave the Mojave with silicon. “The environmentalists got up in arms and said, You can’t just go out and cover a hundred miles square,” Hulstrom said recently as he sat in his office at NREL. But that’s not what he meant. “You can cover parking lots with photovoltaic. You can put it on house roofs.”

Twenty years later, PV panels still contribute only a tiny amount to the nation’s electricity supply. But on rooftops in California, Nevada, and other states with good sunshine and tax incentives, they’re a sight almost as familiar as air conditioners—and though not yet as developed as solar thermal, they may have a brighter future.

Right now the panels are expensive, and they provide an efficiency of only about 10 to 20 percent, compared with the 24 percent of parabolic troughs. History more than physics is to blame. After the solar bust in the mid-1980s, many of the best engineers migrated to the computing industry, which uses the same raw material—silicon and other semiconductors. Following what is called Moore’s law, microprocessors doubled in capability every couple of years, while solar languished. Now some of the engineering talent is moving back to solar.

Researchers at NREL are exploiting the fact that different semiconductors capture different colors from a beam of sunlight. By layering compounds called gallium indium phosphide and gallium indium arsenide and using a lens to concentrate sunlight, they built a PV cell last year that is 40.8 percent efficient (a world record, since broken). But it’s far from ready for mass production. “The technology is incredibly sophisticated,” said Ray Stults, an associate director of the laboratory. “We can make it right now for \$10,000

ENDLESS POTENTIAL

ENERGY EQUAL TO 6,000 TIMES the world's electricity use constantly shines on Earth. Even with current technology, we could harvest enough to supply dozens of times our demand for electricity—but building the infrastructure needed to switch to solar would cost much more at current prices than continuing to burn fossil fuels. As data from NASA satellites show (map, right), the world's solar leaders, notably Germany, are not the sunniest countries but the ones that can afford to pay extra for solar power. Solar costs are falling steadily, however. Developing nations in the subtropics may benefit from that trend; steady sunshine there means investment in solar infrastructure could pay off fast. Most of the world's best solar potential remains unexploited.

Electricity that could be generated worldwide from renewable sources

975,010 TERAWATT-HOURS

470,278 TWh
SOLAR
PHOTOVOLTAIC

275,556 TWh
CONCENTRATING
SOLAR

105,278 TWh
WIND (LAND BASED)

91,398 TWh
OCEAN (TIDAL AND WAVE)

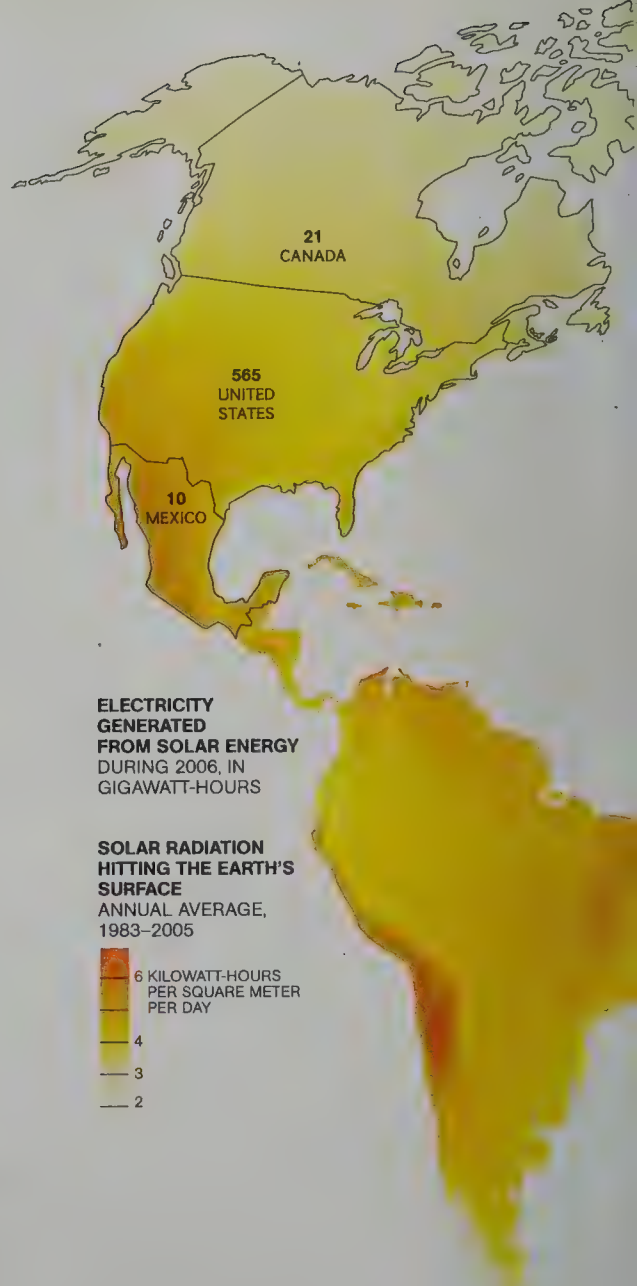
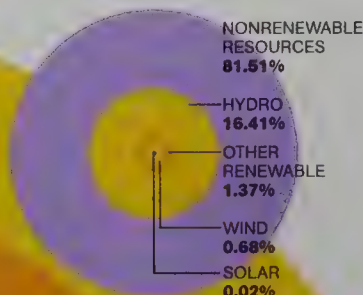
13,889 TWh
HYDRO

12,500 TWh
GEOTHERMAL

6,111 TWh
WIND (OFFSHORE)

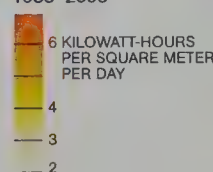
Electricity generated worldwide in 2006

19,015 TERAWATT-HOURS



ELECTRICITY GENERATED FROM SOLAR ENERGY DURING 2006, IN GIGAWATT-HOURS

SOLAR RADIATION HITTING THE EARTH'S SURFACE
ANNUAL AVERAGE, 1983–2005

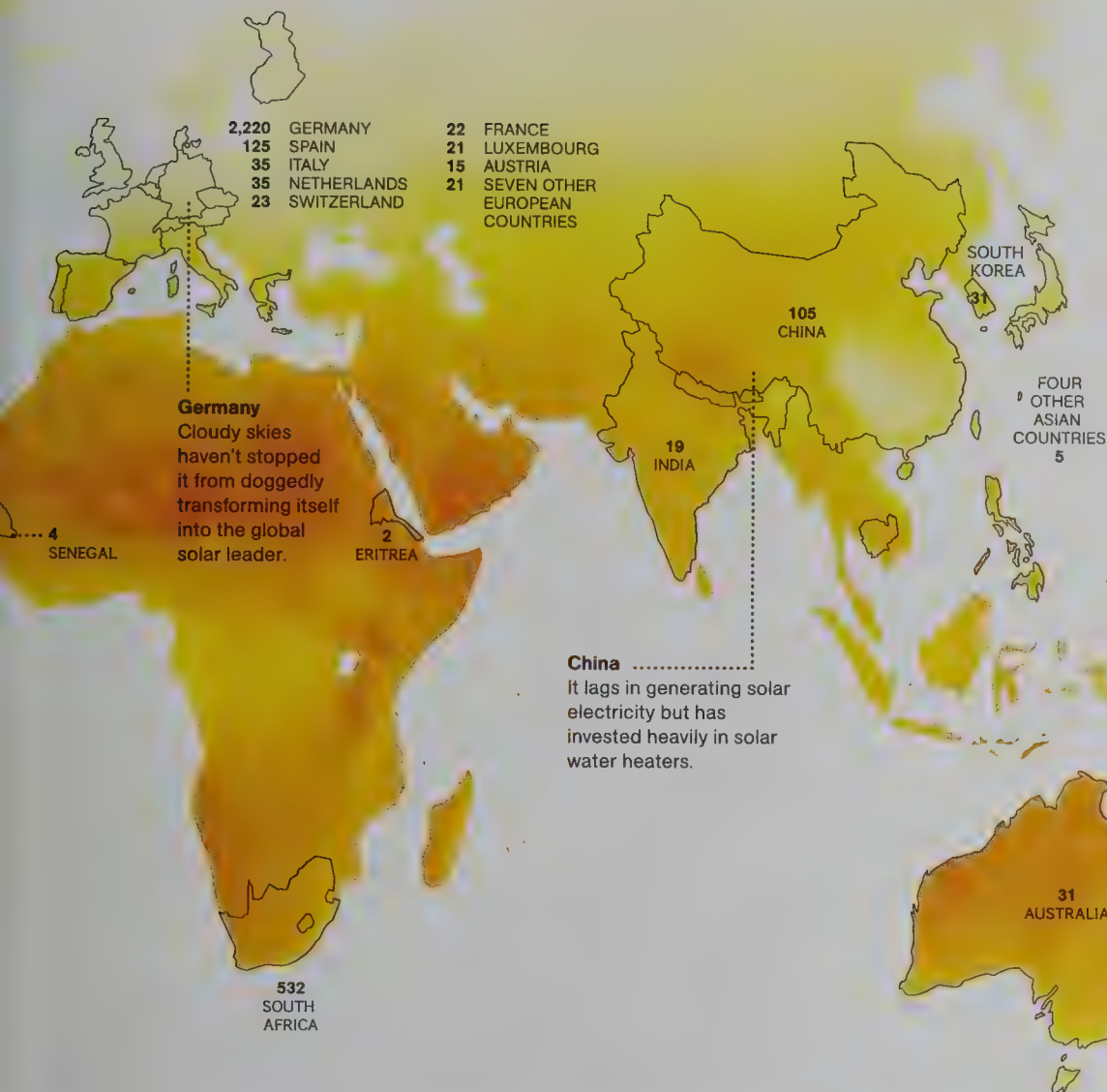


◀ RANKING THE RENEWABLES

The sun's potential for power generation eclipses that of all other renewable energy sources. But for now solar power barely registers in the world's energy portfolio (inset graph). It accounts for only a small fraction of a percent of total electrical output—much less than hydropower or wind energy, which are cheaper to produce.

NOTE: ONE TERAWATT-HOUR = 1,000 GIGAWATT-HOURS = 1 BILLION KILOWATT-HOURS. ONE KILOWATT-HOUR WILL POWER A 100-WATT LIGHTBULB FOR TEN HOURS.

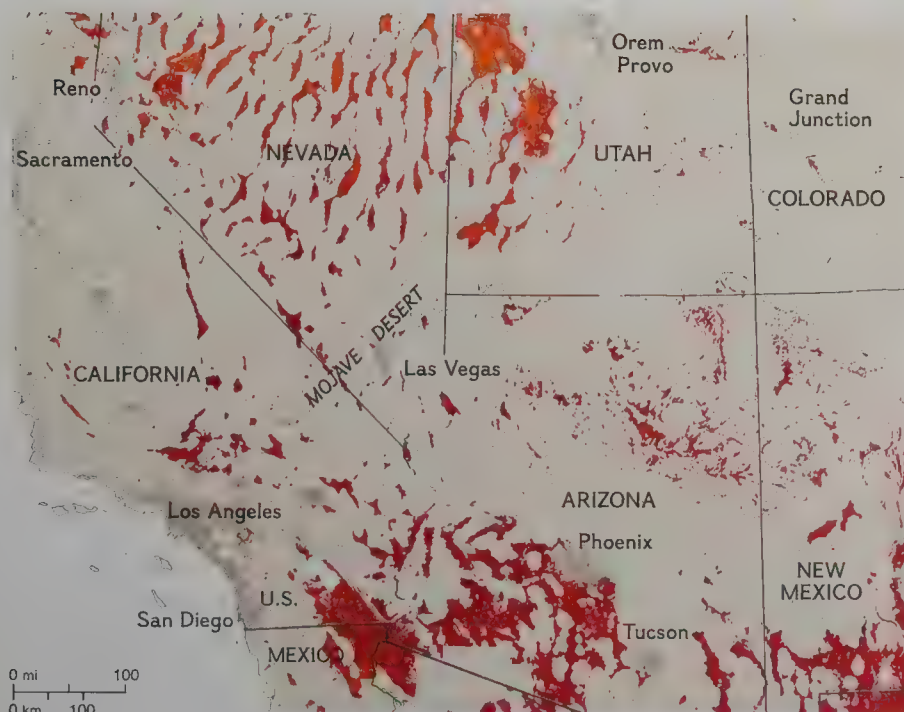
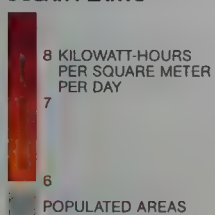
SEAN MCNAUGHTON, NG STAFF
GRAPHIC BY 5W INFOGRAPHICS
SOURCES: NASA (WORLD MAP); WORLD ENERGY STATISTICS AND BALANCES © OECD/IEA, 2008; NATIONAL RENEWABLE ENERGY LABORATORY (SOUTHWEST MAP); ECOFYS (POTENTIAL GENERATION)



THE SOLAR SOUTHWEST

Solar advocates say the desert Southwest could light the entire U.S. Thousands of square miles there (colored areas) are not only sunny but also flat and undeveloped enough for concentrating-solar plants. Some environmentalists oppose the land- and water-hungry projects and the new transmission lines that would be needed.

SOLAR RADIATION SUITABLE FOR USE IN CONCENTRATING-SOLAR PLANTS



**On some days
100 percent of
Nellis Air Force
Base is solar
powered. No
pipes, boilers,
or dynamos—
just photons
knocking elec-
trons off silicon.**

per square centimeter, but not many people are going to buy it.”

Another approach is to trade higher efficiency for lower cost. Though they generate less power per square inch, thin-film semiconductors require less raw material, making them a cheaper alternative for large photovoltaic installations. Two American companies, First Solar and Nanosolar, say they can now manufacture thin-film solar cells at a cost of around a dollar a watt—tantalizingly close to what’s needed to compete with fossil fuels. Looking further ahead, engineers at NREL are working on photovoltaic liquids. “The goal there is to make it the cost of a gallon of paint,” Stults said. “The efficiencies won’t be 40 or 50 percent. They’ll be 10 percent. But if it’s cheap, you can paint your walls, hook it up, and go.”

Photovoltaic panels aren’t limited to individual houses or warehouses. On the northeastern outskirts of Las Vegas, Nellis Air Force Base is supplying an average of 25 percent of its electricity with photovoltaic. On some winter days when there is no need for air-conditioning, 100 percent of the base is solar powered. Last fall, as I looked across the field of 72,416 sun-tracking panels, the wind blowing between the rows, I could see the appeal: There were no oil pipes, heat exchangers, boilers, dynamos, or cooling towers—just solar photons knocking electrons off silicon atoms and generating a current. Constructed in just 26 weeks in 2007 by the SunPower Corporation, the system generates 14.2 megawatts, making it the largest photovoltaic installation in the United States—though only about the 25th largest in the world. Nearly all the bigger ones are in Spain, which, like Germany, has invested heavily in solar power.

None of those plants yet include a storage system. Since photovoltaics produce electricity directly, there is no heat to capture in tanks of molten salt. One option would be to divert some of the photovoltaic current during the day to drive pumps, compressing air into underground caverns. Compressed air has been employed for decades in Germany and Alabama to store the cheaper nighttime output of conventional power plants for use during the daytime peak. At a solar plant the cycle would be reversed: When electricity was needed at night, the pent-up energy from the sunlit hours would be released, rushing forth and spinning a turbine.

Right now people who live off-grid with PV panels on their roofs rely on ordinary batteries to get through the night. In the future they might have solar-powered electrolyzers that split water molecules into hydrogen and oxygen. Recombining the gases in a fuel cell would yield electricity again. The idea is old, but last year Daniel Nocera, a chemist at MIT, reported what may be a breakthrough: a new catalyst that makes splitting water much cheaper. At public lectures Nocera likes to hold up a large plastic water bottle. All of a family’s nighttime electricity requirements, he says, could be stored in five of these, with enough left over to run the electric car.

No one knows in detail the future of solar energy. But there is



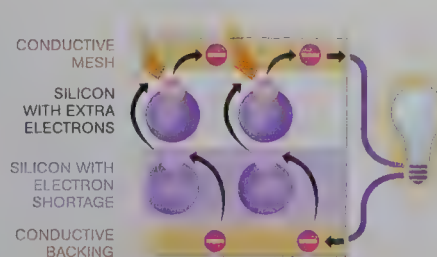
a gathering sense that it is wide open—if we can make the commitment to jump-start the technology. “Originally it seemed like a pie-in-the-sky idea,” Michelle Price, the energy manager at Nellis, told me last fall when I toured the base’s new photovoltaic plant. “It didn’t seem possible.” Many things seem possible now.

ON A COLD DECEMBER MORNING west of Frankfurt, Germany, fog hung frozen in the trees, and clouds blocked the sun. Shivering on a ridge above the town of Morbach, I watched the blades of a 330-foot-high wind turbine swoop in and out of the gloom. Down below, a field of photovoltaic panels struggled for light. Who would have thought that Germany would transform itself into the largest producer of photovoltaic power in the world, with a capacity of more than five gigawatts?

A fraction of this power comes from centralized plants like the small one at Morbach or even the sprawling 272-acre Waldpolenz Solar Park, which was constructed recently with thin-film technology on an abandoned Soviet air base near Leipzig. With land at a premium in Germany, solar panels are mounted on rooftops,

PHOTOVOLTAIC POWER

Solar panels like these on roofs at a Bavarian farm produce electricity when light jars electrons loose in a semiconductor, often silicon (below). Unlike concentrating solar, the other strategy for generating solar electricity, PV systems can operate efficiently on a small scale.



GRAPHIC: 5W INFOGRAPHICS



Above a scorched plain outside Seville, Spain, reflected sunlight reflects again off low clouds. Ordinarily the mirrors at Abengoa Solar's PS10 station beam searing, concentrated light to the top of the "power tower," heating a boiler that makes steam to drive a turbine. On overcast days, operators aim the mirrors skyward; sudden sun through clouds could heat the tower so quickly it could be destroyed.



At a time of economic calamity, the New Deal transformed the nation's energy landscape. Seven decades later we still reap the benefits every time we flip a switch.

farmhouses, even on soccer stadiums and along the autobahn. Though dispersed across the countryside, they are connected to the national grid, and utility companies are required to pay even the smallest producers a premium of about 50 euro cents a kilowatt-hour.

"We are being paid for living in this house," said Wolfgang Schnürer, a resident of Solarsiedlung—"solar settlement"—a condominium complex in Freiburg. Outside, snow was sliding off the solar panels that covered the roofs of the development. The day before, Schnürer's system had produced only 5.8 kilowatt-hours, not enough even for a German household. But on a sunny day in May it had yielded more than seven times that much.

After serving coffee and Christmas cookies, Schnürer spread some printouts on the table. In 2008 his personal power plant generated 6,187 kilowatt-hours, more than double what the Schnürers consumed. When the amount they used was subtracted from the amount they produced, they came out more than 2,500 euros (nearly \$3,700) ahead.

Sitting at the edge of the Black Forest in the southern part of the country, "sunny Freiburg," as the tourist brochures call it, has been transformed by the solar boom. Across the street from Solarsiedlung, a parking garage and a school are covered with photovoltaic panels. In the older part of town, towering walls of photovoltaics greet visitors at the train station. Nearby, at the Fraunhofer Institute for Solar Energy Systems, the next generation of technology is being developed. In one project, Fresnel lenses are used to concentrate sunlight 500 times, raising the efficiency of a standard photovoltaic panel as high as 23 percent.

It is the demand created by the government's "feed-in tariff" that drives research like this, said Eicke Weber, the institute's director. Anybody who installs a photovoltaic system is guaranteed above-market rates for 20 years—the equivalent of an 8 percent annual return on the initial investment. "It is an ingenious mechanism," Weber said. "I always say the United States addresses the idealists, those who want to save the planet—the Birkenstock crowd. In Germany the law addresses anyone who wants to get 8 percent return on his investment for 20 years."

THE MOST SPECTACULAR SHOWCASE FOR the future of solar is probably Plataforma Solúcar, a Spanish solar energy complex on the Andalusian plains. I'd seen photographs of the 11-megawatt power tower called PS10. Rising 377 feet high, it is surrounded by 624 sun-tracking mirrors that reflect light beams toward its crown, igniting a glow that shines like a new star. Next to it, PS20 has since been completed with twice as many heliostats and double the power. But as I crested a hilltop about 15 miles west of Seville, I saw that the German weather had followed me. The valley was enveloped in fog—a reminder that even in torrid southern Spain, solar will



always have to be supplemented by storage and other forms of power.

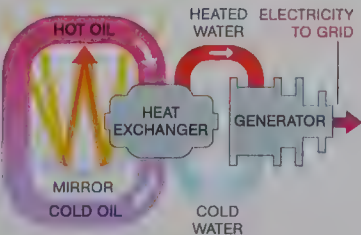
“We had a problem last night—no more tower,” said Valerio Fernández, director of the plant, which is owned by Abengoa Solar, as he met me at the gate. He laughed as we looked up at PS10, its head lost in the clouds. On a normal day, the power focused on the tower could reach four megawatts per square meter—far more than can be safely utilized. PS10’s operators have to limit the flux to avoid melting the receiver.

Power towers are a different version of solar thermal, another way to use sunlight to make steam. Although parabolic troughs are well proven for large, flat areas, power towers can be fit to hilly terrain, the mirrors individually aligned to converge on the elevated boiler. Because a tower heats steam to higher temperatures, it is potentially more efficient.

With the solar industry still in its infancy, however, Abengoa Solar is hedging its bets. Not far from the power towers, cranes were assembling rows of parabolic troughs. Behind PS10 stretched a field of advanced photovoltaics that track the sun on two axes—north-south as well as east-west—to ensure optimal exposure throughout

CONCENTRATING SOLAR

At Nevada Solar One near Las Vegas, oil piped down long rows of reflectors soaks up focused sunlight, becoming hot enough to make steam and run a 64-mega-watt power plant (below). Utilities often favor such systems, also called solar thermal, over costlier PV.

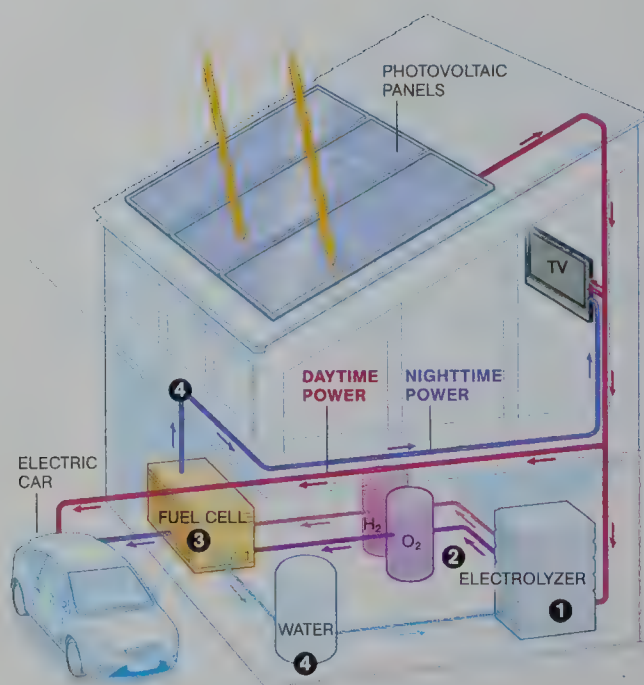




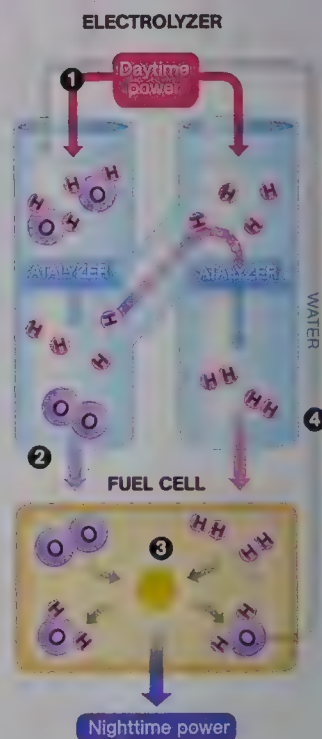
Stretching across terrain already gridded by Andalusian farms, Andasol 1 and 2 rely on the same energy source as the crops. Plants store solar energy via photosynthesis; these concentrating-solar facilities store it by using some of the sunlight they collect during the day to heat thousands of tons of salt. Tapping that heat after sunset allows them to generate electricity for 7.5 more hours.



SOLAR 24/7 Power after dark remains a challenge for the solar home. But a cheap, self-renewing catalyst discovered by MIT researcher Daniel Nocera (right) might allow water to act as a storage medium, keeping the lights on at night and even refueling an electric or hydrogen car. “Your house becomes a power plant,” Nocera says. “It becomes a gas station.”



- 1 Excess daytime electricity from solar panels goes to an electrolyzer.
- 2 Aided by the new catalyst, the solar electricity splits water into hydrogen and oxygen, which are stored.
- 3 When it's too dark for solar power, the stored elements are recombined in a fuel cell, generating electricity.
- 4 Power flows to household appliances and recharges electric-car batteries. The only by-product from the fuel cell—water—is recycled.



the year. Each panel was fitted with mirrors or Fresnel lenses to intensify the light. “Taking profit from every one of the rays of sun—that’s our goal,” Fernández said.

BACK HOME IN THE UNITED STATES I read a magazine article challenging the country to move faster in harnessing the sun: “Every hour, it floods the earth with a deluge of thermal energy equal to 21 billion tons of coal,” the writer had calculated. “The enormous output of solar energy is almost impossible to conceive.” Illustrated with a drawing of a futuristic solar plant with enormous steam-generating mirrors, the article was entitled “Why Don’t We Have... Sun Power?” It was dated September 1953.

This time we might just make it. Last February, BrightSource Energy signed contracts with Southern California Edison for a series of power towers in southwestern deserts that could eventually provide 1.3 gigawatts of power, equal to a large coal-fired plant. Meanwhile, Pacific Gas and Electric has commissioned more than 1.8 gigawatts of parabolic troughs, photovoltaics, and BrightSource power towers. Environmentalists are already preparing to fight some



of these projects; they would all cover large swaths of desert, and some might use a lot of scarce water for cooling. Like any form of power generation, solar has its trade-offs.

And it still has a long way to go. While I was in Nevada, I drove out to Hoover Dam—an early mass producer of renewable electricity—and joined a tour descending deep inside. At the bottom the torrent of Colorado River water falling from Lake Mead was spinning two parallel rows of giant turbines. Just one turbine puts out 130 megawatts, twice the power of Nevada Solar One.

But Hoover Dam left me feeling hopeful. Back on top, as I read the tarnished brass plaques and admired the art deco architecture, I thought about how this country had met the challenges of the Great Depression of the 1930s. The New Deal, as that earlier stimulus package was called, included not only Hoover but also the Tennessee Valley Authority, which brought hydroelectric power to the Southeast, and the Rural Electrification Administration, which strung power lines into the heartland. At a time of economic calamity, the nation's energy landscape was transformed. Seven decades later we still reap the benefits every time we flip a switch. □

CAN SOLAR SAVE US?

PROBABLY.

EVENTUALLY.

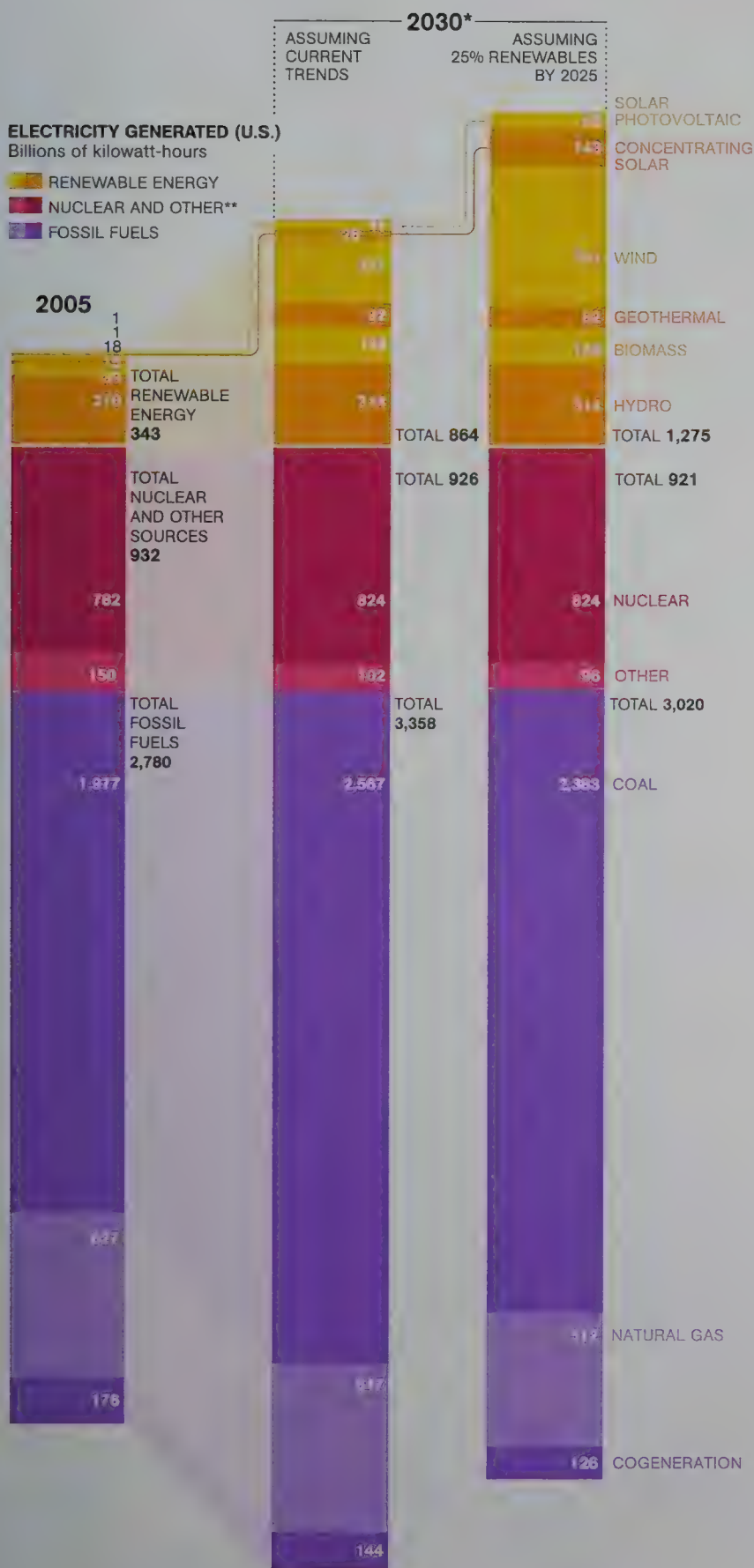
WITH LOTS OF
GOVERNMENT
HELP.

THE SUN IS A UTOPIAN FUEL: limitless, ubiquitous, and clean. Surely someday we'll give up on coal, oil, and gas—so hard on the climate, so unequally distributed worldwide—and go straight to the energy source that made fossil fuels. In a few sunny places where electric rates are high, like Italy and Hawaii, solar energy is already on the verge of being competitive. But in most places the sun remains by far the most expensive source of electric power—typically in the U.S. it costs several times more than natural gas or coal—which is why it still supplies only a fraction of a percent of our needs.

That won't change fast unless governments give solar a big boost. President Barack Obama campaigned with a pledge to institute a federal "renewable portfolio standard" requiring utilities to generate a quarter of their electricity from renewables by 2025. Yet even if Congress enacted that ambitious law, coal would still dominate the nation's electricity portfolio two decades from now, and solar energy would probably remain a minor contributor (chart). Cap-and-trade legislation that sets a price on carbon emissions would not be a magic bullet for solar either. Both mandates would likely lead utilities to favor the cheapest renewables, like wind. Solar would make a sizable contribution only after 2025, once the expansion of wind energy had plateaued.

Some advocates say we need to encourage solar more directly. European nations have done so with "feed-in tariffs," laws that require electric utilities to pay premiums to solar-power producers, be they commercial power plants or private homes that pump energy to the grid. Such tariffs have made Germany and Spain solar leaders, creating a market that has helped drive down prices. The billions of dollars of tax credits and loan guarantees in the Obama stimulus package may have a similar effect.

Another option is for the federal government to invest directly in solar—for example, says Ken Zweibel of George Washington University, by funding the construction of giant solar plants in the desert Southwest, along with the high-efficiency transmission lines needed to carry the power nationwide. In Zweibel's version of the future, the sun would satisfy more than two-thirds of U.S. electricity needs by 2050, for an investment of about \$400 billion. "Compared to what we just paid for the financial bailout, it's pocket change," he says. —Chris Carroll



RENEWABLE FUTURES

Under current policies, solar energy is projected to supply just over one percent of U.S. electricity by 2030 (middle bar). If demand for electricity rises, so will fossil fuel use—and carbon emissions. Requiring utilities to generate 25 percent of their power from renewable sources (right bar) would limit the growth of fossil fuels while pushing solar to 4 percent and wind to more than 10 percent of the total. Such forecasts are highly uncertain; policies and markets can both evolve in unforeseen ways.

*PROJECTIONS BASED ON 2005 DATA

**INCLUDES NONBIOGENIC MUNICIPAL WASTE, REFINERY GAS, AND OTHER SOURCES

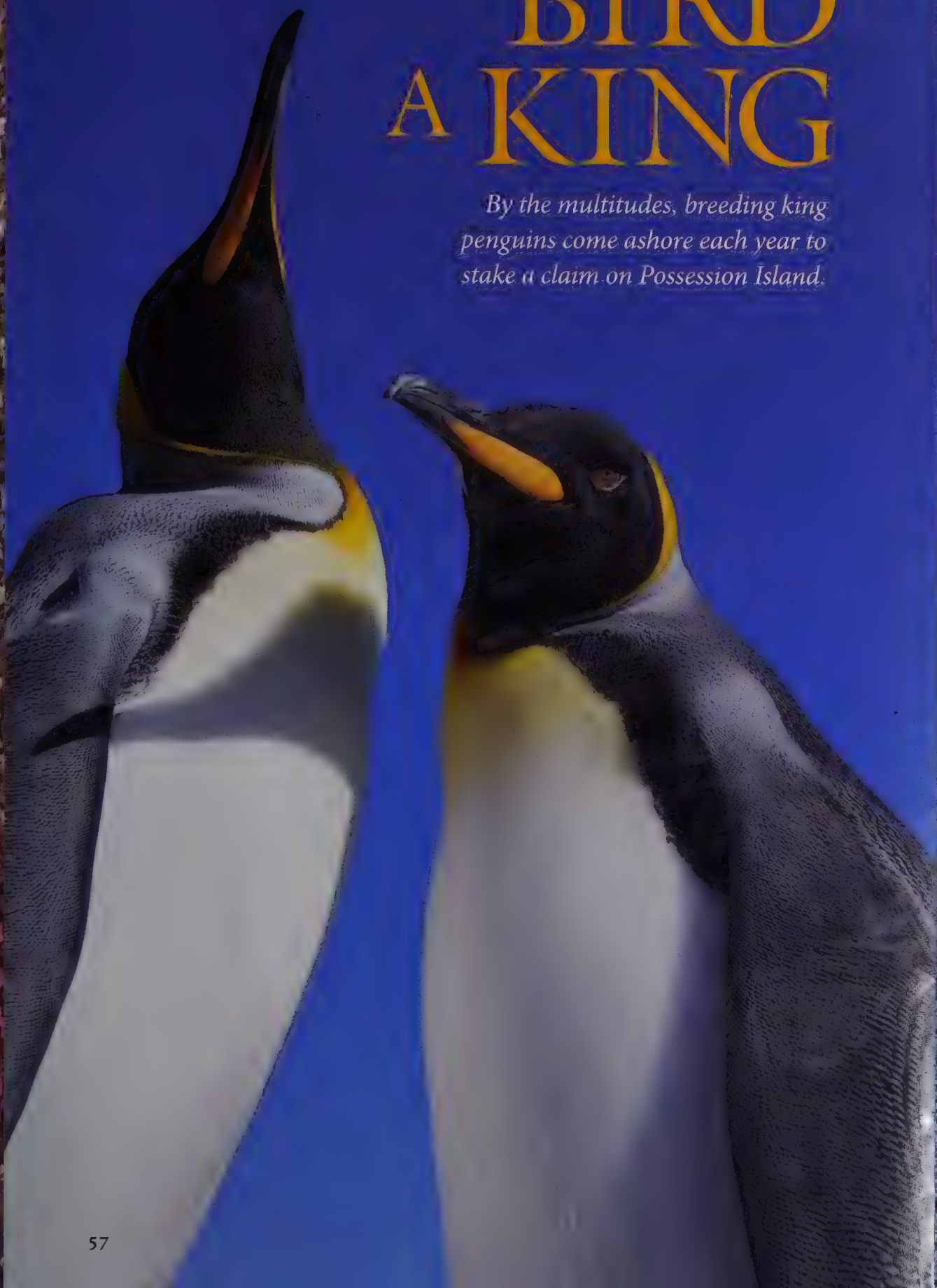
NOTE: NUMBERS MAY NOT ADD UP TO TOTAL BECAUSE OF ROUNDING.

CHART BY SW INFOGRAPHICS
SOURCE: UNION OF CONCERNED SCIENTISTS



EVERY BIRD A KING

*By the multitudes, breeding king
penguins come ashore each year to
stake a claim on Possession Island.*





Ruling a remote, ice-free realm north of Antarctica, king penguins collect at American Bay on Possession Island for a month-long molt before pairing up to rear young.

Preceding pages: In summer kings transform a tranquil valley called Jardin Japonais ("Japanese garden") into a raucous breeding colony of 100,000 birds.





A feeding party streams back to shore after several days at sea. Their orange markings, long, slender bills, and hefty, three-foot-long bodies distinguish them as king penguins. With bellies full of small fish, they will regurgitate a portion for waiting chicks.



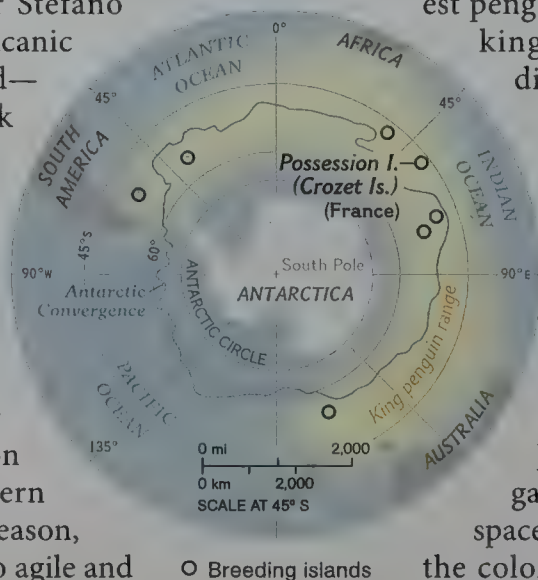


PHOTOGRAPHS BY STEFANO UNTERTHINER

FIRST COMES THE NOISE, the turbulent din of king penguins calling, fighting, courting, like the ultimate schoolyard uproar. Then the smell hits, a choking reek of fish and ammonia from the birds' guano. But the assault on ear and nose is only a teaser for what awaits the eye. When photographer Stefano Unterthiner climbed a volcanic ridge on Possession Island—a wet, wind-blasted speck in the Crozet archipelago some 1,400 miles north of Antarctica—he found himself staring into a valley filled wall-to-wall with king penguins, tens of thousands of them, all standing as if gathered for a mass rally. The occasion was summer in the Southern Hemisphere—egg-laying season, the time when penguins, so agile and

quick in the water, clumsily come ashore to molt, find a partner, and with luck produce a new crop of chicks. Befitting their name, king penguins cut an impressive figure in the seabird court. As tall as three feet and weighing an average of 30 pounds, they are the second largest penguin, after the emperor. The king is also among the most distinctive, with vivid orange detailing on its head, beak, neck, and upper breast.

On Possession Island king penguins have established six breeding colonies, the largest one on 90 acres of boulder-strewn ground that French researchers have dubbed *Jardin Japonais*, or “Japanese garden.” Far from a meditative space, as Unterthiner discovered, the colony seethes with the drama





Going beak to beak, an adult king penguin challenges a skua attempting to make off with a freshly killed chick. Once they reach a few months of age, chicks lose the vigilant daily care of parents and must bunch together for safety and warmth (left). Chick mortality runs as high as 75 percent, many dying of starvation in winter.

of birds defending plots little larger than a manhole cover. King penguins do not build nests. In their constricted space, the male and female take turns incubating a single egg balanced on their feet and covered by a loose fold of skin. They brood the newborn chick in the same way until it grows plumage thick enough to withstand the elements.

During this three-month period, the adults peck at all trespassers. The main offenders are petrels and skuas, avian predators partial to eggs and chicks. Researchers figure that a king penguin parent devotes four hours and 2,000 pecks a day to fighting off interlopers.

"For all the crowding, there was no sense of chaos," says Unterthiner, who stayed on the island from December to April. "The penguins looked very organized, almost like they were in

military formation, each guarding its ground."

King penguins have established colonies across seven islands and island groups in the southern reaches of the Indian and Atlantic Oceans. The islands are crucially located near the Antarctic Convergence, an oceanic boundary where cold polar water meets and mixes with warmer subantarctic seas, producing a rich feeding zone. Prodigious divers and swimmers, king penguins travel 250 miles or more to feed in the depths on squid and bioluminescent lanternfish.

Numbering an estimated 2.2 million pairs, the king penguin population is in good shape. Yet a recent study in the Crozet Islands, where half of all king penguins breed, reveals that warming seas are reducing food resources near the colonies and warns that climate change may pose a serious threat to the species' long-term survival. But for now, the clamor, the stink, and the pecking all bear witness to king penguins still in their full glory. —Tom O'Neill

Tom O'Neill is a senior writer for the magazine. Wildlife photographer Stefano Unterthiner is based in Italy. His latest book is The King's Odyssey.



→ point frosty water about 3-4 km from shore
with 6-8 foot tall waves for sailing persons drive
into shore by 1000m from shore. Once water is calm
water is perfect, but we not say they can catch







Like figures in a dream, king penguins swoop through sunlit shallows wreathed in kelp. "Penguins can seem like fish," says photographer Unterthiner, "but here they truly are birds flying in water."



As sure as moonrise over Possession Island, king penguins gather each year for “ecstatic display.” Puffing their chests, lifting their heads, and belting out calls, birds of both sexes advertise themselves. Before long, pairs form and join a crowd, and breeding season is on.





Ruins overlook streets where fighting tore the capital apart in the early 1990s, leaving the city, and the nation, in chaos.



**MOGADISHU IS GROUND ZERO FOR THE
FAILED STATE OF SOMALIA, A PLACE WHERE
PIRATES AND TERRORISTS RULE. YET TO
THE NORTH, THE BREAKAWAY REGION OF
SOMALILAND IS STABLE AND AT PEACE.
WHAT HAPPENED?**

SHATTERED SOMALIA

**BY ROBERT DRAPER
PHOTOGRAPHS BY PASCAL MAITRE**



WAR WITHOUT END MOGADISHU

Concealed in the courtyard of his home, a street vendor who has joined the Islamist militia called al-Shabaab shows off his gun. The group has fought the newly formed transitional government with assassin's bullets, grenade attacks, and roadside bombs—and now controls most of southern Somalia.



A speeding pickup filled with Transitional Federal Government (TFG) forces narrowly misses women cleaning a capital street. With turmoil all around them, residents barely remember what life under a stable government is like.





EVERY AFTERNOON MOHAMMED GOES TO THE LIGHTHOUSE.

It is not an obvious refuge. Built nearly a century ago, the Italian lighthouse has been in disuse for years. Its spiral staircase is in a state of mid-collapse. Its hollowed-out rooms smell of sea rot and urine. Young men sit cross-legged in the rubble, chewing qat—a plant whose leaves contain a stimulant—and playing a dice game called *ladu* for hours. Some huddle in a corner and smoke hashish. They seem like ghosts in a city left for dead. But the lighthouse is quiet and it is safe—if anyplace in Mogadishu can be considered safe.

Mohammed, 18, comes for the view. From the top floor he sees the ruins of his neighborhood in the once illustrious Hamarweyne district. He can see the remains of the former American Embassy, the posh al Uruba Hotel, the Shangaani district, once teeming with gold merchants and perfume emporiums—all now blasted away. A lone goat stands in the middle of the main road, while the centuries-old houses alongside it slowly crumble, occasionally burying alive the squatters who inhabit them. Mohammed can also see, just below the lighthouse, the small crescent of sand where he and a few other guys sometimes improvise a game of soccer and the naked children clinging to chunks of discarded Styrofoam as they bob on the waves. He can take in this daily paradox of joy and destruction if he wishes. But he prefers to gaze farther out, at the unspooling carpet of tranquillity that is the Indian Ocean. “I spend my time looking at the sea,” he says, “because I know that my food comes from there.”

Mohammed is a fisherman. Every morning at five he pushes out into the water with his nets in a small boat. Whatever Mohammed catches, he hauls by wheelbarrow to the market. On mornings when the wind is not too hazardous, his catch fetches two or even three dollars—

which means that he, his parents, and his two younger siblings will have enough to eat that day. A mortar blast incapacitated his father years ago, and his family has depended on Mohammed’s income since he was 14. He cannot afford the ten-dollar monthly cost to attend school. And anyway, all his former schoolmates have disappeared. Most have joined the Islamic extremist militia called al Shabaab, which in Somalia’s latest chapter of misery is locked in a ferocious power struggle with the Transitional Federal Government (TFG), a shaky alliance backed by the United Nations. For young males like Mohammed, al Shabaab is a tempting exit strategy from powerlessness. Then again, many of his former playmates are now dead.

Mohammed has grown up in a country that has collapsed. He had just been born when Somalia’s last president, a cultish dictator named Mohamed Siad Barre, was overthrown and the country descended into decades of sustained anarchy. He is one of an entire generation without the slightest clue of what a stable republic looks like. They are learned in other things, however. “M16s, mortars, grenades, bazookas—I can tell each one apart as soon as I hear it,” he says.

Somalia’s northern coastline, overlooking the approaches to and from the Gulf of Aden into the Indian Ocean, is a base for pirates preying on sea traffic between Europe and the East. When I visited the country last year, Somali pirates were attacking scores of ships off its coast. Yet I found the country’s interior to be, if possible, even more volatile. Since then, fierce clashes between insurgents and government troops have accelerated even further as Ethiopian forces, which had invaded Somalia late in 2006 to oust a short-lived Islamic government and prop up the TFG, pulled out in January 2009. The chaos has invited a fresh flow of



In the quiet of an abandoned lighthouse, young people chew qat. The mild stimulant makes the hardships of life in Mogadishu feel more bearable. Ten airplanes loaded with qat arrive at a nearby airport every day.

foreign fighters to Somalia, which has become a haven for terrorists who see themselves engaged in a global jihad. The Fund for Peace has ranked Somalia number one on its index of failed states for the past two years. (See “Why Things Fall Apart,” page 98.) That distinction understates the pathos of Somalia. Failure—to deliver security, sustenance, services, or hope—has, for 18 years now, been the house that Somalis call home.

And they are leaving their home in droves. The lucky ones migrate outside the conflict zone—on harrowing journeys to refugee camps in Kenya or Yemen, or to Somaliland, the breakaway republic that once formed Somalia’s northern swath. Those less fortunate—more than a million of them—have ended up in camps for internally displaced persons. But many choose to remain in Mogadishu, a city that looks, at first glance, like most of its kind in Africa. A crazed tangle of battered automobiles, mule-drawn carts, and untended goats rules the pocked streets. The markets teem with brilliant mangoes and bananas and junk merchandise

from the West. Women in Muslim head scarves pass by, as do boys kicking soccer balls and men with cheekfuls of qat.

Yet amid the exoskeletons of banks and cathedrals and luxury hotels overlooking a glimmering coastline that once buzzed with pleasure boats, an awful truth dawns. Mogadishu was never like other African cities. Mogadishu was a spectacular city. Even in its disfigurement, the beauty is still there—above all, in ghostly Hamarweyne, where photographer Pascal Maitre and I stand in the empty boulevard and squint out at the sea until a call to prayer from a nearby mosque reminds us it is almost five in the afternoon, after which all outside activity ceases. Anyone on the streets of Mogadishu by evening is inviting misadventure.

Just before leaving, we go to the lighthouse, where we meet Mohammed. He sees us, two

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gaalo, or infidels, and our guards, and at first we hear his footsteps as he retreats somewhere into the shadows. Later he emerges and grows talkative. “We don’t want to flee our own country,” he tells me. “I don’t want to be a refugee. We’re ready to die here.”

THIS LAND IS BRED FOR TROUBLE. Its nearly 250,000 square miles are, for the most part, deadly dry. Somalia’s inhabitants have engaged in a constant competition for its scarce resources—water and pasturage—since antiquity. According to the great Somali ethnographer, I. M. Lewis, Somalia’s occupants “form one of the largest single ethnic blocks in Africa.” By tradition they are herders of goats and camels and cattle who share the same Islamic faith and the Somali language, and until the colonial era in the late 19th century they continuously occupied much of the Horn of Africa—including what is today Djibouti, northeastern Kenya, and the eastern portion of Ethiopia. In the Somali psyche, fierce nationalism coexists with equally fierce pastoral individualism. It is not their way to look to government for solutions.

What held Somalia together—and sometimes drove it apart—was its elaborate clan system. The five principal clan families, Darod, Dir, Isaaq (sometimes considered a Dir subclan), Hawiye, and Rahanweyn, have long dominated particular expanses of territory. Within these clans are various subclans and sub-subclans—some cohabiting peacefully and even intermarrying, others sporadically hostile. “You’ve always had a conflict-prone nomadic society in Somalia, going back to precolonial times,” says Andre LeSage of the National Defense University in Washington, D.C. “There was tribal raiding of livestock, but it happened between organized young groups under the authority of a clan elder. They’d say, ‘Now is the time this can be done,’ and some were killed in pitched battles. But women’s and children’s lives were generally spared, and villages weren’t razed. We shouldn’t overly idealize that period. Female genital mutilation was prevalent, and obviously society lacked the benefits of modern health care. But

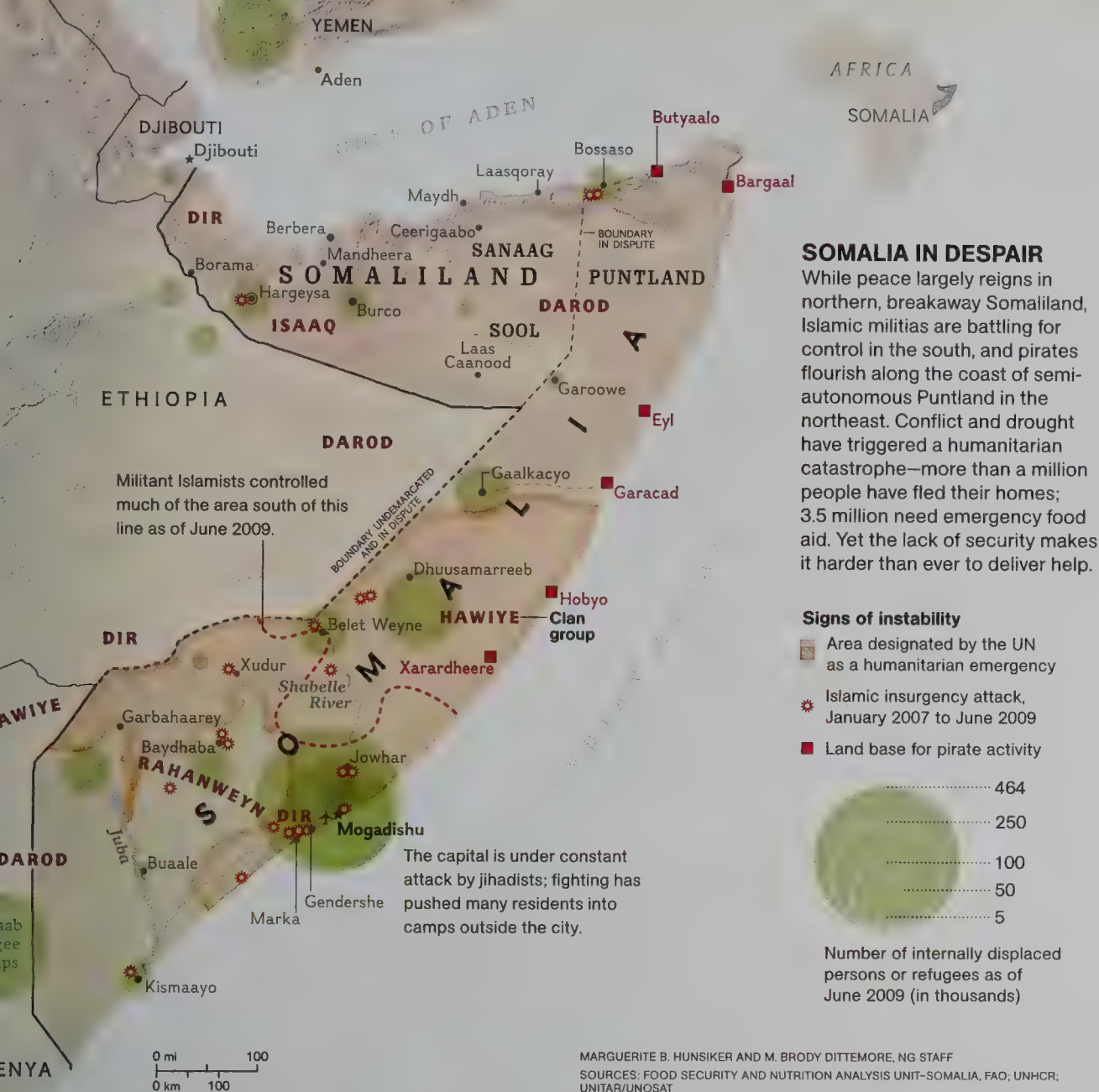
it wasn’t anarchy at all. It was highly regulated.”

The clan-based checks and balances began to crumble with the arrival of the Europeans. The British in Somaliland ruled with a lighter hand than did the Italians in the south. Though Mogadishu, under Italian rule, became a city of cosmopolitan amenities, the Italians politicized Somali clan hierarchy by rewarding loyal elders, punishing the less loyal, and controlling commerce. Local mechanisms for conflict resolution were badly damaged.

In 1960 the colonial powers departed, and a dreamy nationalism seized the Somali people. With visions of a unified country, Somaliland and Somalia confederated. But nationalism was soon thwarted by clan divisions that had been aggravated during colonial rule. The knotty hostilities left a power void. Into it stepped the dictator General Mohamed Siad Barre in 1969. Barre (a member of the Darod clan) ruled with clever brutality, and many Somalis today speak nostalgically of the stability of his reign. Publicly he outlawed clans, promoting socialism over tribalism and stripping elders of judicial authority. But behind the scenes he practiced a divide-and-rule politics that only worsened clan tensions. Meanwhile, Barre alternately courted the U.S.S.R. and the U.S., with huge stockpiles of weapons as Somalia’s principal harvest. An imprudent war with Ethiopia weakened his position. In 1991 militias of the Hawiye clan chased Barre out of Mogadishu. The Somali people, weary of occupiers and strongmen, awaited the next iteration of government.

Eighteen years later, they are still waiting.

MOHAMMED WAS AN INFANT when the civil war between rival militias swallowed up the Hamarweyne district in 1991. “Four months of fighting, right here in our neighborhood,” he remembers his parents telling him. “We couldn’t get any food. Everyone was so scared.” One day a mortar obliterated his neighbors’ house and killed the people inside. Some of the shrapnel flew into the home of Mohammed’s family, penetrating the neck and rib cage of his father, a policeman under Barre. The family hitched a ride with



neighbors northward to Hargeysa in Somaliland, where they stayed for three months. They returned to Mogadishu to find Hamarweyne gutted and gaping holes in their roof.

“We had to start from scratch,” Mohammed remembers. The mortar wounds had left his father disoriented and unable to hold a job. Mohammed took to the streets to polish the shoes of strangers, but his mother insisted he quit working and start attending school. Relying on money from an aunt who lived in Saudi Arabia, they got by. During the rainy season, water poured through the roof and flooded their house.

A few years ago, Mohammed’s best friend was killed by a mortar while walking along the street. Mohammed couldn’t sit in the classroom without thinking of the boy. He quit and became

the fisherman he is today, sometimes hauling his daily catch to the sprawling Bakaara market, though the neighborhood there is in the hands of al Shabaab militia. He remembers showing up at the market one day and finding ten people lying motionless in the street. He remembers trying to sleep that night and instead seeing the faces of the dead.

Asked to recall memories of when life was good, Mohammed stares out toward the sea. His smile is not of the youthful kind. “I don’t remember any,” he says.

TWO WEEKS before my arrival, Mohammed’s father woke up in the morning with his usual headache, a lingering result of his injury. He had volunteered to join a group, mostly women, to clean up the rubbish along Maka al Mukarama



WHAT HELD SOMALIA TOGETHER— AND DROVE IT APART—WAS ITS ELABORATE CLAN SYSTEM.

Road—the main thoroughfare from the Mogadishu airport—in exchange for food. He arrived an hour late, just in time to hear the explosion. Lying along the road were his co-volunteers—cut to pieces by a roadside bomb, their faces seared beyond recognition. A child stood, glassy-eyed, over the bodies. Forty-four women were taken to the hospital. Half of them were dead.

The violence has a psychic hold on the city, yet is strangely elusive to visitors. The damage is near but not so near until, in a fearsome rush, it claims you. And thus, it is possible to wake up at six in the morning to concussive blasts, as I do on my fourth morning in Mogadishu—to walk downstairs and out into the shaded patio of our fortified hotel and discover the innkeeper rocking serenely in his swing as he sips his Yemeni coffee, the beans for which he keeps hidden in his bedroom. As I take my seat, he asks if I enjoyed the kingfish we were served the night before. We talk about his children who have emigrated to North Carolina and Georgia. About the power and intelligence of Siad Barre. (“There isn’t another, and there won’t be another!”) About Barack Obama, the excellent pasta he remembers eating in the Italian city of Bergamo, his side business in Dubai—and yes, a bit about the early morning blasts, which turn out to have been mortars launched by insurgents at TFG troops (and which instead killed several innocent civilians), followed by a prolonged exchange of gunfire in the city center. The violence comes up in conversation only glancingly, as a detached happenstance, thoroughly surreal.

Except it’s all too real. Later that morning, we visit Medina Hospital, as we have every day since our arrival, in a macabre ritual. Two days ago we visited the women recovering from the roadside bomb on Maka al Mukarama Road—badly burned, several missing limbs, and many visibly pregnant. The new explosion near our hotel has added another 18 victims and sent the hospital into critical mass. The floors and walls are streaked with blood. Disfigured patients lie on stretchers in the hallways and on the porch. Clusters of family members stand nearby—all

of them worried, surely, but no one sheds a tear.

While bullets fly and bodies fall, government officials assure us, without the slightest abashment, that everything is under control. “Yes, the tide is turning. The people hate al Shabaab because of what they’ve done,” says Abdifitah Ibrahim Shaaweey, deputy governor for security affairs of the region around Mogadishu, a baby-faced fellow who tours the city with a massive convoy and whose predecessor, his father, was killed in the conflict two years ago. “Of course there are many places where the government has opposition,” the commander of Somalia’s national army, Yusuf Dhumal, puts it tactfully. He then adds, “But in many parts of the country, there’s support for the government,” citing several regions of the country—including the semiautonomous northeastern region of Puntland, where pirates flourish. Yet control is slipping away. We drive that afternoon through one of the “controlled” districts to find that its main road has just been blocked off, after a policeman was shot dead there.

SOMALIA’S ONGOING MALAISE can be bewildering to outsiders. “We go into these war-torn countries trying not to be pessimists,” says Ken Menkhaus, a Horn of Africa specialist at Davidson College in North Carolina. “But in Somalia we have to recognize that the cynics—those who dismiss peace initiatives as doomed to fail—have turned out to be right for almost 20 years.”

Skepticism about Somalia’s prospects was tempered briefly in early 2009 when the Ethiopian withdrawal offered hope that the insurgency would fade. A power-sharing accord produced a new version of the TFG, now a broad-based government led by moderate Islamists, which has strong international support. But the new government has struggled to maintain control, as both al Shabaab and

Brimming with charcoal from southern Somalia’s dwindling forests, a truck rolls toward a port in Mogadishu. From there the charcoal will be shipped to Persian Gulf countries like Saudi Arabia, which enforce laws protecting their own trees.



LIFE IN A LAWLESS LAND A man pierced by shrapnel from a mortar strike near a mosque joins the scores of wounded who arrive almost daily at Medina Hospital (top right). Since early 2007 Mogadishu has lost more than half its population, as civilians flee fighting between the government and insurgents. Many of the roughly 750,000 people who remain are the poorest of the poor, like the mother and baby sheltering under a bullet-ridden truck at a feeding center (bottom right). Jobless, often homeless, faced with soaring food prices, they survive on humanitarian relief. On the shore children still play, and fishermen drop anchor nearby, but the hulks of derelict hotels (below) stand vacant.







Clutching bowls, boys wait at a feeding center for what could be their only meal of the day—a soup of corn and lentils. Once aid groups handed out dry rations. Now they distribute food cooked, to avoid attracting looters.





IN A PLACE GONE TO HELL, AL SHABAAB IS THE BEST EMPLOYER IN TOWN.

another hard-line Islamist insurgency, Hizbul Islam, have taken over much of central and southern Somalia. By June forces loyal to the fragile government held only seven of Mogadishu's 18 districts. The latest fighting has killed more than 200 people and displaced tens of thousands more.

Why is the violence so intractable? A clarifying paradigm can be found immediately to the north, in Somaliland. No visual distinction marks the Somalilander from the Somali. But the naked eye detects plenty of differences between the two regions. Somaliland's capital city of Hargeysa is an almighty wreck of sledgehammered streets, ungoverned traffic, litter, and refugee camps, but there are two things there that you will not find in Mogadishu. The first is a construction boom—of hotels, restaurants, business centers. The second are the currency-exchange booths everywhere on the streets, where women sit alongside yard-high stacks of Somaliland shillings, unaccompanied by security of any sort.

What one almost never sees in Hargeysa is violence. The last time the weapons of Somaliland came out was in 1996, a few years after the fabled peace conference in the town of Borama. Barre had been deposed, and opposing warlords engaged in a civil war to the south, threatening the stability of the north. At Borama a group of elders came together to reconcile clan conflicts at what one participant calls "the Guinness record kind of conference—months of talking and finally agreeing on a charter to set up a government. And while we were having this conference, out in the countryside, everyone came and put their guns under a tree."

Because the fledgling democracy has relegated much authority to elders and sheikhs, peace has largely endured. (A startling exception occurred last October when a string of suicide bombs—apparently arranged by al Shabaab—went off in Hargeysa, leaving dozens dead.) Somaliland has benefited from greater clan homogeneity and a port at Berbera that does not suffer the piracy afflicting the Somali coast.

True prosperity, however, has not followed;

Somaliland is hardly on track to be the next Dubai. The commercial thoroughfare connecting neighboring Ethiopia to Hargeysa and to the port at Berbera is largely untrafficked, with roadside goats and camels more in abundance than cars. The Somaliland city of Burco is a bustling aggregate of low-slung market stalls, its ethos deeply in the sway of Islam. The highway linking Hargeysa and Burco to the vast Sanaag region's administrative capital of Ceerigaabo simply disappears a couple hundred miles shy of its destination—requiring an eight-hour trek the rest of the way through roadless desert, with only the occasional oasis shanty or camel herdsman to rely on for navigation. And the once impressive canopy of acacia trees beyond the northern peaks of the Sanaag region has been badly plundered (as have forests throughout Somalia). The lumber is burned to charcoal, bagged in burlap sacks, and then barged out to Persian Gulf countries. "They're just poor people making money to feed their families," acknowledges Ceerigaabo's mayor. "But it's a bad mistake. I wish the international organizations could help by bringing in some other means of livelihood."

This sentiment is universally expressed throughout Somaliland, which no government has recognized as a sovereign nation. In Somalia it may feel as if the world has abandoned the country, but from Somaliland's perspective, its southern neighbor has stolen the world's attention. "This is the question I ask when I go to Europe and the U.S.," says Somaliland's president, Daahir Rayaale Kaahin. "Why does Somaliland, with all its success, not receive support from the international community, while Somalia receives all this aid and yet never makes any success? Nobody answers me." President Rayaale's request has begun to receive sympathy from some outside nations, but generally the wish seems to be that Somaliland stand united with—and thereby help rescue—Somalia.

President Rayaale believes this is a misguided approach. "Leave aside this dream of a Greater Somalia," he says. "Let us just be a good neighbor, a functioning state near them. Let

them sit like we have sat, under the trees.”

But if we ask the Somalis to sit under the trees, will they leave their weapons there?

THE TERRORIST SELLS SOFT DRINKS and ice from his market stall in southern Mogadishu. He is 22, tall, and bony, with beautiful eyes and a sweet smile. He offered a furtive wave as we drove past. We met the next day, after he had spent the evening with his lieutenants, praying together and fashioning explosives.

The young man is an emir for al Shabaab—originally the youth militia for the Islamic Courts Union (ICU), an alliance of sharia courts that united to take control of southern Somalia during the summer and fall of 2006. The ICU’s creeping radicalization and expressed desire for a Somali caliphate was what prompted Ethiopia (with U.S. backing) to invade Somalia, defeat the ICU, and bring the TFG to power later that year. The ICU’s brief reign was largely peaceful, but its offspring—the al Shabaab militia—has shown a far greater appetite for violence and reportedly has links to al Qaeda.

At one time, this young emir had 120 mujahideen under his control. “Now I have about 60 or 70,” he said when we spoke last year. “The others have left the country. Or they’re in paradise.” In a quiet, almost ephemeral voice, he explained that al Shabaab’s aim was “to reclaim the country and establish an Islamic state. Until our last daughter is no longer alive, we’ll continue fighting. We don’t want democracy. If they leave us to our dignity, we can rule Somalia.”

He discussed his rigorous training and how a top al Shabaab leader, Aden Hashi Ayro—later killed by an American air strike for his ties to al Qaeda—personally taught him how to construct land mines. When I asked him where al Shabaab was getting its supply of munitions, he said that much had been purchased across the border, from Kenya. But, he added, “we’ve received some support in the past from Eritrea, with their big guns and ammunition, and now they’re ready to support us further. But there’s no way to get the weapons to us overland.” The solution, he explained, was for them to capture the

southern coastal town of Kismaayo, an area of heavy conflict between the government and the extremists. “If we get it,” he said, “then we’ll have our own port. And we can receive what we need from there.”

Less than an hour after he left, our fixer received a call. Kismaayo had just fallen to al Shabaab. The extremists would soon have their fill of weapons.

WE WILL PAY YOU \$150. Members of al Shabaab approached Mohammed and offered the young fisherman an advance payment in American cash if he would join their organization. Every month, they told him, you will be paid that same amount for your services. Mohammed did not say yes. But he also did not say no.

Mohammed brought up the matter with his family. For years they had been subsisting on fish and corn. A salary like that could make a big difference. In a place gone to hell, al Shabaab is the best employer in town and offers direction amid daily uncertainty. For weeks the family debated the pros and cons. Mohammed himself was in anguish. Most of his friends who had joined al Shabaab had been deported, arrested, or killed. And this fact, more than any moral epiphany, is what ultimately carried the day. As Mohammed’s father would tell me, “When you join, you cannot leave. His colleagues who had joined—they never came back to their families. So it’s better that he work at the sea and catch fish.”

The father’s eyes are watery as he recounts this. “Mohammed is taking care of us,” he says quietly. “It affects me psychologically that our child must have this responsibility.”

FOOD IS POWER IN SOMALIA. Militia groups have routinely descended on the arable lands of central Somalia during harvest and claimed the crops for themselves. Pirates on the Indian Ocean have waylaid dozens of foreign vessels bearing food aid. Food prices were high here even before last year’s worldwide spike, thanks to drought, militia roadblocks, and a devalued currency. The result is that millions now depend on food aid. The fresh fighting is pushing the country

THE LOCALS STARE AT THE FOREIGNERS. WORD OF THE KIDNAPPINGS HAS SPREAD.

toward an unprecedented humanitarian crisis.

The violence displaces people from their homes, which causes an upsurge in crowds at the feeding centers in Mogadishu. Lines form before the gates open at noon. The hungry stand with their bowls, chatting with each other, dignified as Somalis always seem to be. Behind the gates, workers funded by Western and UN donors stir large vats of millet and vegetables. None of them are foreigners, but because they are funded by Western agencies, they do not wear their official tunics around town for fear of being kidnapped or killed.

As the gates slide open, a woman files in, sees me, and whispers something to an aid worker: "Tell him we're praying for the gaalo because they're feeding us. The jihadists don't feed us anymore. They're killing us."

THE KILLING IS ALL AROUND US. But the danger does not come our way until our eighth day in Somalia. We drive out Saturday morning in two SUVs filled with armed guards, bound south for the Italianate coastal town of Marka. The 60-mile stretch of road between the two cities is almost entirely in the control of al Shabaab. (In the following months, al Shabaab will win control of Marka and most cities in south-central Somalia.) Because of this, the one-day trip is the fruit of lengthy negotiations between our fixer and the insurgents. It is understood that once we leave Mogadishu's city limits, our TFG-sanctioned guards will depart our vehicle and be replaced by militia guards. Such precautions cost money, which we are fortunate to have. Two journalists in a car a few miles behind us are not so lucky.

They are youthful freelancers—one from Australia, the other from Canada—and they have just arrived, possessing determination but little experience or money. They have convinced a fixer to take them to an internally displaced persons (IDPs) camp about ten miles outside of Mogadishu, along the same road we are traveling. They have paid for TFG guards, but not for militia security to ferry them the final few miles to the refugee

camp. Their gamble proves to be a fateful one.

The highway teems with wandering refugees and with convoys bearing heaps of charcoal from the forests to the south. Thirty minutes into our trip, our fixer says to us, "I've been calling the others. They're not picking up." He phones the journalists' TFG security. Yes, their car made it to the city-limits checkpoint. He phones the IDP camp. They have not arrived. By the time we arrive in Marka, a member of al Shabaab calls with the news. The two freelance journalists have been kidnapped. The ransom will likely be a million dollars each. The presence of the other two gaalo along the same stretch of highway has been duly noted. All bets are off for us.

We spend the evening at a guesthouse in Marka. It is not safe to drive back to Mogadishu the way we came, and it's the only road to the city. A United Nations plane is due to arrive in two days; we could take it back to Nairobi, though our luggage and passports are at the hotel in Mogadishu. In the end we decide on another course. A powerful man in Marka offers to loan us his militia of a dozen heavily armed, young men affiliated with al Shabaab. They will escort us to the city limits, where our TFG unit will bring us back to the hotel and then to the airport. The cost is \$500 in cash. The thoroughfare will be the beach along the Indian Ocean.

We wait the next morning for the tides to roll back the waves. Then, just before eleven, we pull out of the guesthouse and trundle through town—our two SUVs plus a flatbed truck loaded down with a dozen young men with M16s, Kalashnikovs, ammo belts, and an immense rotating machine gun bolted to the bed of the truck—while the locals stare at the foreigners with knowing eyes, as word of the kidnappings has spread. We drive through the markets, past a small mountain of tortoise shells, and then nothing is before us but the beach. The waves thrash against the tires. The militia men chatter excitedly amongst themselves, and whenever the truck gets stuck in the sand—which is every one or two miles—they jump out of our car to push. I can't help but think: There is little to



Near the ruins of Somalia's old parliament, an unemployed traffic officer directs traffic for tips from drivers grateful for a sign of normalcy. "He thirsts for stability," says Somali journalist Harun Hassan. "It's inspiring."

prevent these men from keeping our \$500 and taking us hostage as well.

The beach gives out without warning a quarter of the way into our trip. A dirt road appears and leads us into the town of Gendershe, once favored as a resort town. Now it is in the hands of Islamic militants. The road narrows as we enter the handsome stone village, and several men appear. They instruct our escorts to turn off the music in our car. Their eyes widen when they see the two gaalo. But a few of the men in the truck know the Islamic elders, and minutes later we are motioned through to the other end of Gendershe, where a checkpoint rail is lifted and we are allowed to pass through.

The beach soon reappears. A couple of small fishing boats are visible, and a few goat herders, and that is all. At about the halfway point, during one of the militia truck's many mechanical failures, all of the passengers step out of their vehicles, and we all stride toward the ocean and gaze out into the horizon. I break out a box of granola bars. We chew and we stare and we take

pictures, and it is at precisely this moment that I realize we will be OK.

Back at the hotel we are hugged by the employees. Mohammed the fisherman and his father come to see me a final time. I hand him \$20. He gives \$15 to his father and keeps the other \$5. "Qat and cigarettes," he says with a smile. "That's my night."

The Mogadishu airport is full of passengers—many of them with heavy bags, indicating that this is their goodbye as well. All of them stare at the gaalo, and I wonder if there is a final surprise in store for us.

There is. One by one, they walk up to us. And shake our hands. And tell us, through our fixer, how sorry they are about the other journalists. How grateful they are that we have come. How sad it is that things are this way. How hopeful they are that we can tell the outside world.

As this story goes to press, despite diplomatic efforts, the two journalists are still being held for ransom. And Somalia's people are still waiting for peace. □

GOING IT ALONE SOMALILAND

Townsmen in the breakaway Republic of Somaliland shoulder goats to a boat for export. Hundreds of miles separate the former British colony from the turmoil in southern Somalia. With no international recognition and scant outside help, Somaliland's leaders have built a stable, functioning government.





In a cocoon of calm, women have their hair styled and feet decorated with henna in Hargeysa, Somaliland's capital. "We are peaceful, not like Somalia," says salon owner Zamzam Mohamed. "We will develop our country."





OASIS OF ORDER Central-bank staff inspect newly printed Somaliland shillings, an independent currency created in 1994, a few years after Somaliland broke away from chaotic southern Somalia. Somaliland's fledgling government has managed to successfully crack down on pirates with a robust arrest policy. Last year authorities detained a crew led by Farah Ismail Eid (below, at left), now serving a 15-year sentence in Mandhera Prison. Rebuilt after dictator Mohamed Siad Barre bombed it flat in the late 1980s, Hargeysa is in the midst of a construction boom—with hotels like the City Center (bottom right)—mostly financed by returning expatriates. But experts worry Islamic extremists may be infiltrating Somaliland: In October 2008 suicide bombers struck locations across the capital.





On her own in drought-stricken Sool, along Somaliland's disputed eastern border, a nomadic woman watches over her herd. Largely abandoned by the rest of the world, Somalis struggle to carry on in a lawless land.





WHY THINGS FALL APART

IT CAN HAPPEN AFTER ONE FATEFUL EVENT—a civil war, natural disaster, or brutal takeover—or insinuate itself gradually, like a cancer that eats away at a country for decades. But when a nation is failing, you see it in the eyes of its people.

Over a billion people live in countries in danger of collapse. Some leaders lose control over their territory and cling to their capitals while warlords rule the provinces. Many governments are unable or unwilling to provide the most basic of services. Most are hobbled by corruption and environmental degradation. Such unstable states are dangers not just to themselves but also to the whole world. They incubate terrorism, criminal organizations, and political extremism—because when your country is falling apart around you, any way out can seem like a good way out.

Geography can make a country more vulnerable to instability. Just finding itself in a bad neighborhood puts a country at risk; the war in Iraq, for instance, sent a flood of refugees into neighboring Syria. Crowded nations with huge populations, like Bangladesh, face special challenges. But so do vast countries like Chad, whose very size defeats infrastructure. Landlocked nations with poor soil and little water struggle for self-sufficiency. Yet countries rich in natural resources, such as the Democratic Republic of the Congo, don't always come out ahead. In what is called the resource curse, abundant oil or diamonds can breed competition among elites for control of those lucrative assets.

Historical and cultural tensions can dog nations as well. Nowhere is this more evident than in Africa, home to the top five countries in this year's Failed States Index (right), compiled annually by the Fund for Peace. "The colonial drawing of arbitrary borders across ethnic and

even topographic lines created artificial states," says the Fund's president, Pauline H. Baker. Such regimes often devote more energy to consolidating authority than to fostering national identities and robust government institutions.

One African country that has prevailed over its colonial legacy is Senegal. "It's benefited from enlightened leadership," says Baker. Indeed, the most important factor for ensuring a state's stability is good governance, says Davidson College political scientist Ken Menkhaus. Establishing the rule of law, with institutions to support it, "allows for a predictable investment climate and discourages the rise of armed insurgencies."

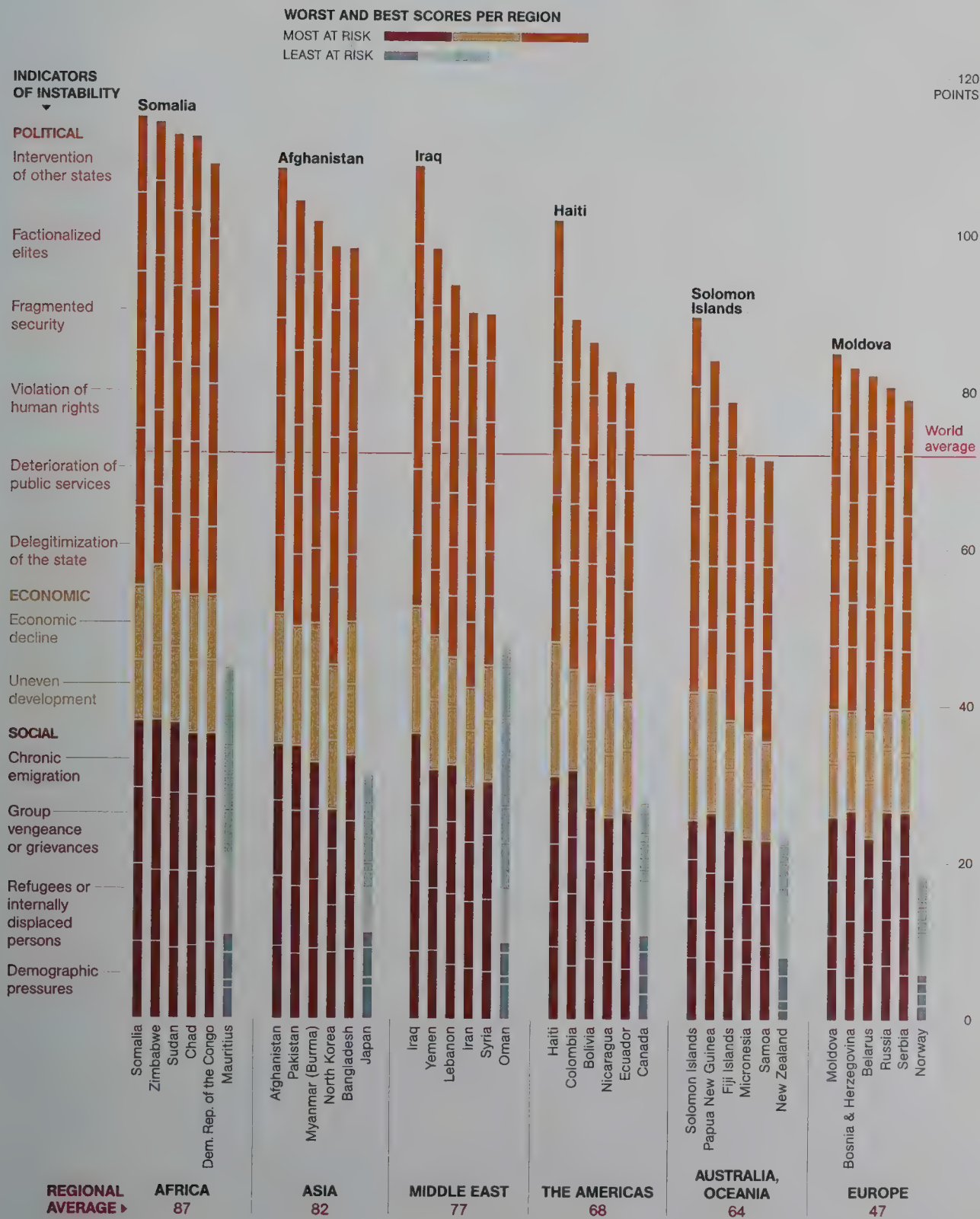
Assistance from organizations like the World Bank and United Nations has a mixed record of staving off failure. The most dramatic success stories are countries like India and South Africa that reformed themselves from within. As the United States' recent experiences in "nation building" illustrate, promoting political stability with outside military intervention is far from easy. Iraq and Afghanistan currently rank as the sixth and seventh most precarious states on the planet.

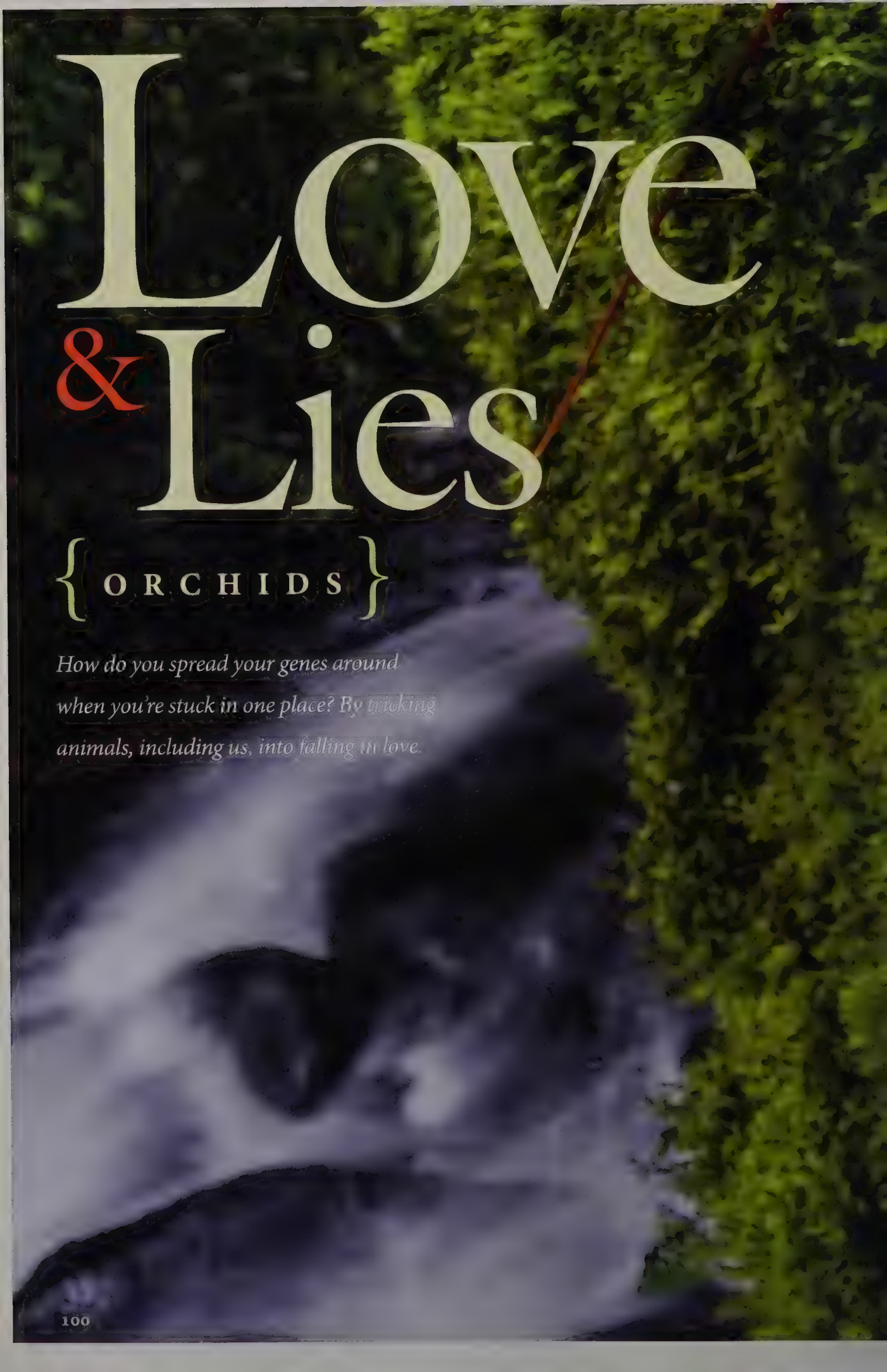
Then there is Somalia, a country whose geography, history, and clan dynamics give it the grim distinction of topping the index for two years in a row. Beyond Somalia, there's little agreement on what a high score on the index really means for a country's future. Colombia, for example, lacks control over parts of its territory. So, has Colombia failed? The bloody aftermath of Kenya's 2007 elections caused the country to go from 26th to 14th in this year's index. But does this backslide foretell failure for Kenya, with its vibrant entrepreneurial class?

Scholars caution against judgment. University of Hawaii professor Tarcisius Kabutaulaka says it's easy to forget that many countries have had troubled histories. "The United States was built out of chaos, out of civil war. And now we expect the rest of the world to adopt our institutions but do it without violence in a short period of time."

In the end, the question of whether a country is failing may best be answered by its own people. If their eyes say "we have been deserted," the verdict has been rendered. —Robert Draper

THE 2009 FAILED STATES INDEX ranks Somalia highest for the second year in a row. Issued since 2005 by the Fund for Peace and *Foreign Policy* magazine, the index weighs 12 political, economic, and social factors to calculate a nation's instability and focus world attention where support is needed.

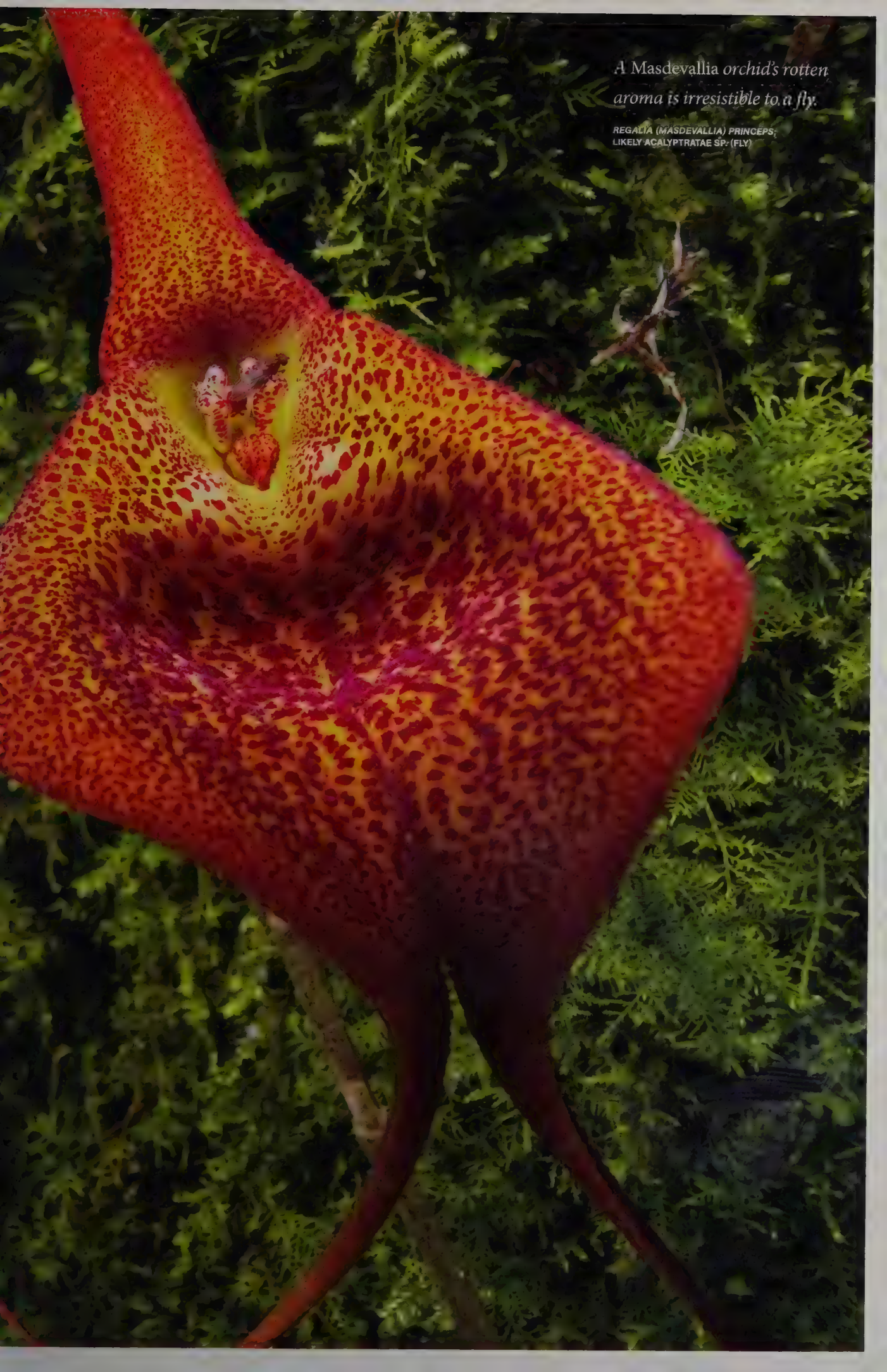




Love & Lies

{ ORCHIDS }

*How do you spread your genes around
when you're stuck in one place? By tricking
animals, including us, into falling in love.*



A Masdevallia orchid's rotten
aroma is irresistible to a fly.

REGALIA (MASDEVALLIA) PRINCEPS;
LIKELY ACALYPTRATAE SP. (FLY)

On the island of Sardinia,
the flowers of mirror orchids
perfectly mimic the reflection
of blue sky on a female wasp's
wings. Male wasps, beguiled
by the flower's sight and scent,
are lured into service carrying
pollen from plant to plant.

OPHRYS SPECULUM





Following a perfume trail
to its source, male wasps in
Australia ravish a king spider
orchid. Sure the red "lip" is
a mate, they rub against it;
one will take away the plant's
pollen. Every orchid has a
petal modified for pollina-
tion, some theatrically so.

CALADENIA PECTINATA; THYNNID WASP





BY MICHAEL POLLAN

PHOTOGRAPHS BY CHRISTIAN ZIEGLER

W

E ANIMALS don't give plants nearly enough credit. When we want to dismiss a fellow human as ineffectual or superfluous, we call him a "potted plant." A "vegetable" is how we refer to a person reduced to utter helplessness, having lost most of the essential tools for getting along in life. Yet plants get along in life just fine, thank you, and did so for millions of years before we came along. True, they lack such abilities as locomotion, the command of tools and fire, the miracles of consciousness and language. To animals like ourselves, these are the tools for living we deem the most "advanced," which is not at all surprising, since they have been the shining destinations of our evolutionary journey thus far. But the next time you're tempted to celebrate human consciousness as the pinnacle of evolution, stop to consider where you got that idea. Human consciousness. Not exactly an objective source.

So let us celebrate some other pinnacles of evolution, the kind that would get a lot more press if natural history were written by plants rather than animals. (I suppose an article by a biped named Pollan will have to do.) For while we were nailing down locomotion, consciousness, and language, the plants were hard at work developing a whole other bag of tricks, taking account of the key existential fact of plant life: rootedness. How do you spread your genes around when you're stuck in place? You get really, really good at things like biochemistry, at engineering, design, and color, and at the

art of manipulating the "higher" creatures, up to and including animals like us. I'm thinking specifically of one of the largest, most diverse families of flowering plants: the 25,000 species of orchids that, over the past 80 million years or so, have managed to colonize six continents and virtually every conceivable terrestrial habitat, from the deserts of western Australia to the cloud forests of Central America, from the forest canopy to the underground, from remote Mediterranean mountaintops to living rooms, offices, and restaurants the world over.

The secret of their success? In a word, deception. Though some orchids do offer conventional food rewards to the insects and birds that carry their pollen from plant to plant, roughly a third of orchid species long ago figured out, unconsciously of course, that they can save on the expense of nectar and increase the odds of reproducing by evolving a clever deceit, whether that ruse be visual, aromatic, tactile, or all three at once. Some orchids lure bees with the promise of food by mimicking the appearance of nectar-producing flowers, while others, as in the case of a *Dracula* orchid, attract gnats by producing an array of nasty scents, from fungus and rotten meat to cat urine and baby diaper. (Believe me, I've sniffed them.) Some orchids promise shelter, deploying floral forms that mimic insect burrows or brood rooms. Others mimic male bees in flight, hoping to incite territorial combat that results in pollination.

But perhaps the most clever deceit of all is offered by those orchids that hold out the



LIPARIS SP.

Rabbit-shaped flowers hop to life on a tree in Borneo. The fingernail-size blooms belong to a tropical genus that rings the Equator and may date back some 80 million years.

WHAT I LEARNED OF THE PROSTITUTE ORCHID FORCED
ME TO REVISE MY ESTIMATION OF WHAT A CLEVER PLANT IS
CAPABLE OF DOING TO A CREDULOUS ANIMAL.

promise of sex. And not exactly normal sex. Really weird sex, in fact.

HOPING TO OBSERVE some of this plant sex, said bipped recently journeyed to Sardinia, a wind-swept, mountainous, and lightly populated island 120 miles off the west coast of Italy that has long been known for floral biodiversity and human kidnapping. (Deceit is evidently very much in the air.) I went in search of one of the most ingenious and diabolical of orchids: the *Ophrys*. (Some botanists call it the “prostitute orchid.”) I’d been eager to lay eyes on this orchid and meet its hapless pollinator ever since reading about its reproductive strategy, which involves what my field guide referred to as “sexual deception” and “pseudocopulation.” What I learned of the prostitute orchid forced me to radically revise my estimation of what a clever plant is capable of doing to a credulous animal.

In the case of this particular *Ophrys*, that animal is a relative of the bumblebee. The orchid offers no nectar or pollen reward; rather, it seduces male bees with the promise of bee sex and then insures its pollination by frustrating precisely the desire it has excited. The orchid accomplishes its sexual deception by mimicking the appearance, scent, and even the tactile experience of a female bee. The flower, in other words, traffics in something very much like metaphor: This stands for that. Not bad for a vegetable.

Orchid hunting can be arduous in many places, but in the mountains of Sardinia *Ophrys* orchids grow like roadside weeds. When they bloom in April you can spot them from a moving car. Close up, the lower lip, or labellum, of these diminutive orchids bears an uncanny resemblance to a female bee as viewed from behind. This pseudobee, which in some *Ophrys* species comes complete with fake fur and what appear to be elbows and folded iridescent wings, looks as though she has her head buried

in a green flower formed by the actual flower’s sepals. To reinforce the deception, the orchid gives off a scent that has been shown to closely match the pheromones of the female bee.

When it comes to getting an orchid pollinated, sexual deception has an uneven success rate (more on that later), but when it does work, it works like this: The real male bee alights on the beelike labellum and attempts to mate, or in the words of one botanical reference, begins “performing movements which look like an abnormally vigorous and prolonged attempt at copulation.” In the midst of these fruitless exertions, the bee jostles the orchid’s column (a structure that houses both the male and female sexual organs), and two yellow sacs packed with pollen (called the pollinia) are stuck to his back with a quick-drying gluelike substance. Frustration mounts, until eventually it dawns on the bee that he has been had. He abruptly flies off, pollinia firmly attached, in frantic search of more authentic female companionship.

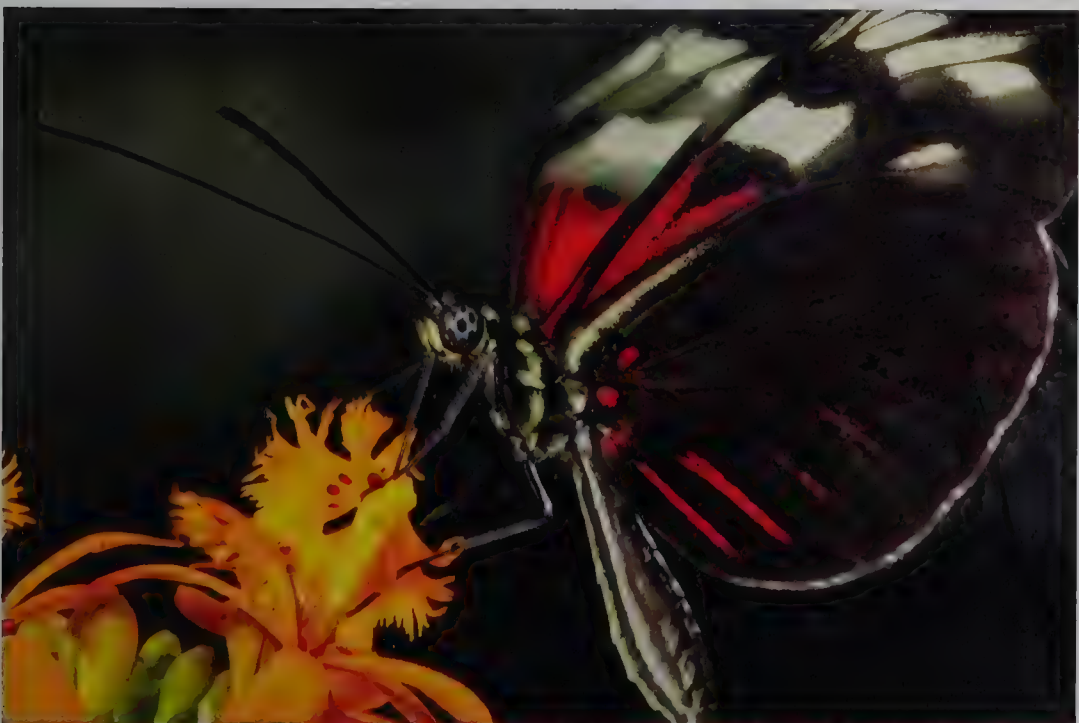
There was something poignant about the bee I spotted, flying around madly with what looked like a chubby pair of yellow oxygen tanks strapped to his back. He’d been deluded by the promise of sex—bee sex—when in fact all that was on offer was plant sex, and unbeknownst to the bee, now searching for a second, more satisfactory liaison, he was right in the middle of that act. Botanists have been known to refer to pollen-carrying bees as “flying penises,” but of course most of the world’s bees perform in that role unwittingly, with food rather than sex on the brain. Not so for the poor, deluded orchid bee.

THE POLLINATION STRATEGY of the *Ophrys* is, like that of so many orchids, ingenious, intricate, wily, and seemingly improbable—so much so that proponents of intelligent design sometimes point to orchids as proof that the hand of a higher intelligence must be at work in nature. (And a rather sadistic intelligence at that.) Yet the peculiarities of orchid sex actually offer one of the great case studies of natural selection, as Charles Darwin himself understood. Darwin

Michael Pollan is the author of In Defense of Food and The Botany of Desire, to be adapted for public television this fall. Christian Ziegler’s photographs of plant mimicry appeared in last month’s issue.



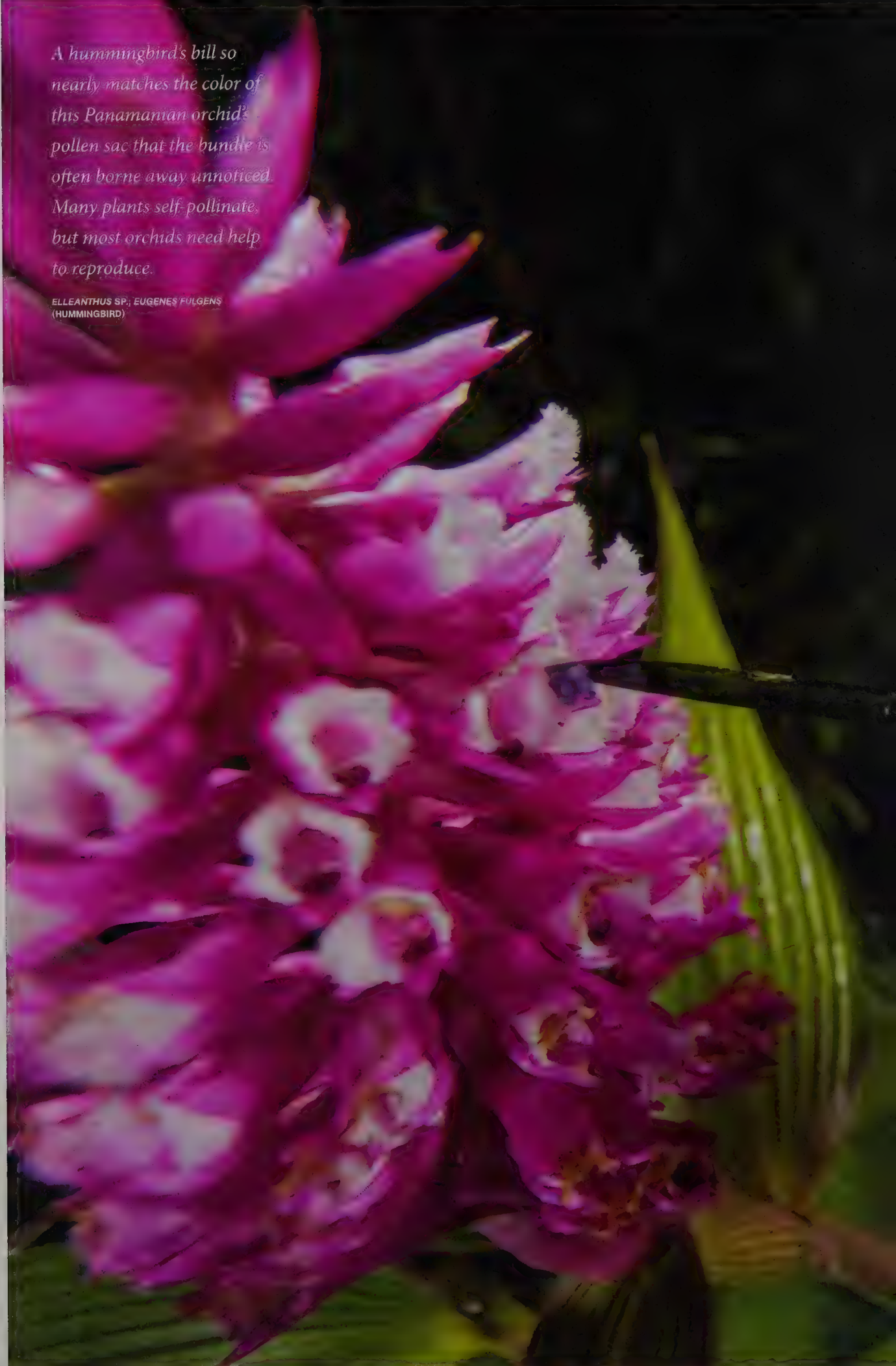
Different pollinators warrant different wiles. To affix yellow pollen sacs to a male sand bee, a wild Italian hybrid (above) dresses up like a female bee. To recruit a butterfly for gene distribution, an Epidendrum in Panama (below) imitates milkweed, a favored food. More ruses come to light among the 500-odd new wild orchid species discovered yearly.



TOP: OPHRYS ELEONORAE X O. LUPERCALIS; ANDRENA SP. (BEE). ABOVE: EPIDENDRUM RADICANS; HELICONIUS MELPOMENE THELXIOPE (BUTTERFLY)

A hummingbird's bill so
nearly matches the color of
this Panamanian orchid's
pollen sac that the bundle is
often borne away unnoticed.
Many plants self-pollinate,
but most orchids need help
to reproduce.

ELLEANTHUS SP.; EUGENES FULGENS
(HUMMINGBIRD)





WHY WOULDN'T NATURAL SELECTION WEED OUT INSECTS SO FOOLHARDY AS TO MATE WITH NATURE'S VERSION OF THE INFLATABLE LOVE DOLL?

was fascinated by orchid pollination strategies, and though he was puzzled by the purpose of *Ophrys*'s uncanny resemblance to bees (pseudocopulation wasn't observed until 1916), he taught us much of what we know about these plants in *The Various Contrivances by Which Orchids are Fertilised by Insects*, the volume he published immediately after *The Origin of Species*. Indeed, some scientists believe that had he published his orchid book first, the theory of natural selection might have encountered less skepticism than it did. Why? Because in orchids Darwin identified floral structures "as perfect as the most beautiful adaptations in the animal kingdom." He painstakingly demonstrated how even the most unlikely features of these flowers serve a reproductive function, and many of these structures are so perfectly adapted, both to the plant's requirements and the morphology of its pollinators, that they offered Darwin elegant proofs of his outlandish theory.

In one famous case, putting the final QED on Darwin's proof that evolution had tailored a flower to lure and exploit a specific pollinator had to wait a few decades. Attempting to explain why the star orchid of Madagascar would secrete a drop of nectar at the tail end of a foot-long floral spur, where no known pollinator could possibly get at it, Darwin hypothesized the existence of a moth with a 12-inch-long tongue, an unlikely creature that had never been observed. Vindication arrived a couple decades after Darwin's death, when entomologists unfurled the tongue of a newly discovered hawk moth and found that it measured nearly a foot long.

THE ORCHID'S BAROQUE pollination strategies do raise challenging questions for the evolutionist, however. Since natural selection seldom rewards the unnecessary complication, why haven't all orchids stuck with the more straightforward pollination strategies based on nectar reward? And how in the world did their sexual practices get so elaborate? As for the hoodwinked pollinators, what, if anything, do they gain? If the answer is nothing but

frustration, then why wouldn't natural selection eventually weed out insects so foolhardy as to spend their time mating with nature's version of the inflatable love doll?

Botanists and evolutionary biologists have come up with fascinating answers to many of these questions. John Alcock, an evolutionary biologist and author of *An Enthusiasm for Orchids*, proposes two explanations for why some orchids would have evolved to avoid a simple nectar reward. When botanists experimented by adding a nectar reward to a normally nectarless orchid, they found that the pollinators hung around longer, happily visiting other blooms on the same and nearby plants. This does not suit the orchid's interests, however, since inbreeding results in lower quality seeds. By comparison, outcrossing, or mixing one's genes with distant mates, increases vigor and variation in one's offspring, maximizing fitness. The sexual frustration of a deluded bee turns out to be an essential part of the orchid's reproductive strategy. Determined not to make the same mistake again, the bee travels some distance and, if things work out for the orchid, ends up pseudocopulating (and leaving his package of pollen) with an orchid a ways off. That distant orchid is likely to look and smell ever so slightly different from the first, and some botanists believe these subtle variations from plant to plant are part of the orchid's strategy to prevent bees from learning not to fall for a flower. "Imperfect floral mimicry" is the botanical term for this adaptation. Think of it: The very imperfection of the orchid's mimicry may itself be part of the perfection of its reproductive strategy.

Another reason so many orchids have gotten out of the restaurant business may have to do with the benefits of developing a relationship with a single, highly devoted pollinator. Nectar, besides being metabolically expensive for the flower to produce, is beloved by so many different animals that it attracts all sorts of riffraff that may not deliver your pollen to the right target. But if you produce a scent that attracts only the males of one particular species of bee, you can insure that your pollen will end up precisely



CATASETUM VIRIDIFLAVUM

Male flowers of tropical Catasetum orchids conceal a pollen-loaded slingshot, which fires its sticky bundle when a prospective pollinator jostles the trigger. Bees are prime targets.

where you want it: on the stigma of a far-flung orchid of your own kind.

The exactitude of the perfume business may also help explain the astounding diversity of the orchid family. A mutation producing even a slight change in an orchid's scent could, strictly by chance, turn out to be the key that unlocks the sexual attentions of a new pollinator, while at the same time completely turning off the original pollinator. In this way, variations in the chemistry of floral scent can function much as geographic isolation does in the creation of new species, by preventing new mutant flowers from being pollinated by older ones. The novel orchid might evolve in genetic isolation from its forebears—a prerequisite for creating a new species.

Orchids have excelled at spinning off new species, and yet there are remarkably few orchid plants in the world. Their relative rarity in the landscape puts a premium on highly

customized pollination strategies to deploy their pollen as efficiently as possible—unlike grasses, for instance, which can simply broadcast their pollen on the wind. Yet their small numbers ensure their survival. If deceptive orchids were much more common, their ruses would no longer work, since they depend on the ubiquity of honest flowers. Orchid deception can succeed only in a world where most things in nature really are what they seem: where the smell of rotting meat signals rotting meat, where flowers really do offer nectar and don't dress up as bugs.

It seems fair to say that when it comes to their own sex, orchids have opted for quality rather than quantity. For while sexual deception doesn't fool all of the pollinators all of the time, it does fool some of them some of the time, and for an orchid that is quite enough. That's because each pollinium contains a stupendous number of pollen grains, and once they're delivered, every resulting seedpod contains an





*Courting bees and beetles,
the nectarless pansy orchid
impersonates a nutrition-rich
neighbor, the pea flower. It's
unique to Australia, an
evolutionary hothouse that
Perth botanist Kingsley Dixon
says "bulges with deception."*

By David Mamet

*They look like birthday bows
festooning Panama's brush, but
it's the aroma of bucket orchids
that draws pollinating bees.
Smithsonian horticulturist
Tom Mirenda says that to
them, the flowers' smell is as
luscious as "five kinds of
dessert baking at once."*

CORYANTHES PANAMENSIS





**TODAY THERE ARE 100,000 HYBRID ORCHIDS, THE
OFFSPRING OF MARRIAGES AMONG FAR-FLUNG PLANTS
ARRANGED BY, AND INCONCEIVABLE WITHOUT, US.**

equally stupendous number of seeds. So while sex among the orchids may be a rare and intricately choreographed affair, what happens after the match is made is all about profligacy and chance. Orchid seeds are so tiny and minimalist they don't even contain a source of food for the developing embryo. For this, the orchid must (once again) count on the kindness of strangers—in this case, that of an endophytic fungus. If all goes right (and here again, it seldom does), the tendrils of the fungus infiltrate the orchid seed and provide the nutrients that the developing embryo needs to grow. What does the fungus get out of the relationship? Don't be so sure it gets anything—these are orchids, after all.

GASPAR SILVERA is an orchid hunter and breeder in Panama given to wearing straw fedoras and married to a woman named Flor. An agronomist by training, Silvera has, since retiring from government service, devoted himself to rescuing orchids from the threat of development and to the painstaking work of propagating them. Photographer Christian Ziegler and I flew to his nursery in Chilibre after Silvera phoned us to report that one of his *Coryanthes*, the Central American bucket orchid, a species notoriously difficult to keep happy in captivity, had bloomed. We were hoping to witness one of nature's most dramatic PG-rated pollination scenes.

By the time we got to the nursery, the canary yellow flower, a surprisingly ungainly Rube Goldberg contraption, was already fading, though it still gave off a powerful perfume of apricots and eucalyptus. The flower had thrown open its elaborately engineered petals just a few days before, and the spicy-sweet perfume had summoned out of the surrounding woods a band of male euglossine bees, a sleek, stingless, iridescent relative of the bumblebee. The bees competed with one another for space on the slick curves of the intricately sculpted flower, directly above a labellum that forms a deep bucket, into which the flower drips a clear, slightly viscous liquid.

Nectar it is not.

Visiting bees busy themselves scraping fragrances from the waxy surface of the flower using their front legs; they then transfer the scents to tibia sacs carried on their rear legs like little wallets. Exactly what they're up to wasn't understood until 1966, when a botanist named Stefan Vogel figured out that the bees were collecting the chemical building blocks needed to create a scent. Most animals that rely on scents to attract a mate produce it themselves; not the euglossine bee, which forages for a specific set of ingredients, gathering them not only from orchids but also from certain leaves and fungi, and then mixes up the perfume by "hand." Once he's concocted his mixture, the bee spreads it on his body and flaps his wings to release a captivating scent of camphor and flowers to summon a female.

But the bucket orchid exacts a steep price for its contribution to this perfume. As the bees jostle each other for scents, one or more of them is apt to lose his footing on the slick petal and plunge into the bucket. This wouldn't be a problem, except the viscous liquid in the bucket renders the bee's wings temporarily useless. So the bee struggles mightily to clamber up the slippery walls of the bucket until he stumbles upon a series of steps, which conduct him up and out of the pool through a narrow passageway leading out the back of the flower. As the dazed and sopping bee squeezes himself through the tunnel, he passes beneath a spring-loaded device that (you guessed it!) claps a pair of yellow pollinia onto his back. If all goes according to (orchid) plan, the bee dries off his wings, flies to another *Coryanthes*, splashes into the bucket again, and on his way out through the tunnel unwittingly snags his yellow backpack on tiny hooks adapted for precisely that purpose. Pollination accomplished, the bucket orchid closes up shop, collapsing its extravagant petals into a wad of crumpled yellow tissue.

The case of the *Coryanthes* is a happy example of an orchid and its pollinator benefiting mutually, but such is not always the case. Although the euglossine bee escapes with his wallet full of scents, that's more than you can say



CORYANTHES PANAMENSIS; EUGLOSSINI SP. (BEE)

Lured into a bucket orchid, a euglossine bee escapes by wriggling out of a hatch fitted just for his species. Along the way, the unwitting insect picks up a pollen pack as a parting gift.

for some other orchids' hapless dupes. If it's starting to sound as though I don't trust orchids, that's because I've seen what they can do to some of my fellow animals. There's a video on YouTube, a riveting snippet of interspecies porn, in which you can watch a wasp be utterly bamboozled, and then humiliated, by an Australian tongue orchid. The tongue orchid (*Cryptostylis*) lures its pollinator by deploying a scent closely resembling the pheromone of the female wasp (*Lissopimpla excelsa*). The male wasp alights on the tongue-like labellum, tail first, and commences to copulate with the flower, probing its interior with the tip of his abdomen until it bumps into the sticky pollinia, which attach themselves to the insect's posterior like a pair of yellow tails.

Having to play pin the tail on the pollinator is only the beginning of the wasp's humiliation. For with the tongue orchid we have passed beyond pseudocopulation into a realm even more perverse: More often than not, the wasp, in the

throes of his misguided sexual exertions, actually ejaculates onto the flower.

Surely this represents the height of maladaptive behavior, and natural selection could be expected to deal harshly with a creature foolish enough to squander its genes having sex with a flower. ("Costly sperm wastage," is how the literature describes it.) That would be bad news for both the wasp and the orchid that depends on him. But as with so much else in the bizarre world of orchid sex, the matter is not quite so simple.

It appears that in some insect species, such as *Lissopimpla excelsa*, females can reproduce with or without sperm from a male. With it, they produce the usual ratio of male and female offspring; without sperm, they produce only male offspring. How convenient—for the tongue orchid, that is. By inducing wasps to waste their sperm on its flowers, tongue orchids are decreasing the amount of sperm available to

female wasps, thereby assuring themselves an even larger population of pollinators. Not only that, but the overabundance of male wasps increases competition for females, which makes the desperate wasps less picky in their choice of mates and that much more likely to fall for a flower.

What about the poor wasp? Why hasn't natural selection killed off an insect so dumb as to have sex with flowers? The best explanation I've heard is from John Alcock, who says that although the wasp may occasionally waste his genes on a plant, his "extreme sexual enthusiasm" is still a better reproductive strategy for an insect than being cautious about one's choice of mate. On balance, having sex with anything that moves yields more offspring, even if it also leads to occasional romantic disaster.

TO LEARN ALL THIS about orchids is to admire them more but, perhaps, love them less. And to wonder if we too have fallen prey to their deceptive charms. Like the scent-gathering euglossine bees, we use them to communicate our romantic intentions and lure mates, extracting their essence for perfumes and wearing them in corsages. Orchids have served us in this capacity since at least 1818, when William Cattley, an English plantsman, rescued a discarded orchid bulb that had been used as packing material in a shipment of tropical plants. The flowering of that specimen ignited a Victorian passion for orchids that has never really subsided.

The very name of the plant comes from the Greek word for testicle, referring not to the plant's flowers but its bulbs, organs that have long been endowed with aphrodisiac properties. But it doesn't take a Freudian to discern a strong sexual subtext in the passion for these flowers, especially among men, who any visit to an orchid show will tell you suffer disproportionately from "orchidelirium"—the Victorians' term for the madness these flowers inspire. Victorians were offended by the "blatant sexuality" of orchids, according to Eric Hansen, the author of *Orchid Fever*; he isn't referring to plant or insect sexuality either.

"Prurient apparitions," is how Victorian critic John Ruskin described these flowers.

Prurient? Is it possible that humans can look at an orchid and, like the deluded orchid bees or male dupe wasps, see an apparition of female anatomy? (Georgia O'Keeffe certainly did.) Could it be that plant sex and animal sex have gotten their wires crossed in human brains just as they have among the bugs? That accident of evolution has proved another happy one for the orchid, for look how much we humans now do for these flowers: the prices paid, the risks to life and limb endured, the pains taken...

Those were my thoughts as I watched Gaspar Silvera deploy a pair of slender forceps to remove a pollinium from a bucket orchid that had failed to entrap a euglossine bee. ("I suppose you could say that I too am manipulated by orchids," he'd explained at the end of a shaggy tale about the lengths he goes to secure choice specimens.) Working with the steady hand of a jeweler, Silvera used the forceps to grab the base of the pollinium and then pressed it to a slit in the column of another bloom. Five years from now, Silvera may find himself with a precious new flower—and the orchid will have offspring it would otherwise not have had.

Ever since the first human-hybridized orchid bloomed (the earliest in the Western world was recorded in 1856), we humans have become important orchid pollinators too—more intentional perhaps than the orchid bees, but lured into advancing the orchid's interests just the same, assisting in its quest for world domination. Today there are some 100,000 registered hybrid orchids, most of them the offspring of improbable marriages among far-flung plants arranged by, and literally inconceivable without, us.

Not that any of this was ever in the orchid's plan. In evolution there is no plan, of course, only blind chance. But the moment that the orchid stumbled upon one of the keys to human desire and used it to unlock our hearts, it conquered a whole new world—our world—and enlisted a vast new crew of credulous animals more than happy to do its bidding. Let's face it: We're all orchid dupes now. □



ORCHIS PAPILIONACEA

To attract bees, this showy Sardinian orchid poses as a nectar-laden buffet, one of the “perfect contrivances” that amazed Charles Darwin—and that continue to fascinate us.



WHEN HENRY HUDSON FIRST LOOKED ON MANHATTAN IN 1609



Turning back the clock by four centuries, ecologists reveal how Manhattan Island appeared on the September afternoon Henry Hudson and his crew sailed into New York Harbor.

An aerial photograph showing a wide river flowing through a landscape of dense green forests and several small, tree-covered islands. The water is a dark, calm blue.

WHAT DID HE SEE?

Before New York

An aerial photograph of New York City, showing the dense urban landscape of Manhattan and the surrounding areas. The Hudson River is visible on the right, and the East River is on the left. Several bridges span the water, and the city's skyline is visible in the background.

Before
New York



TIMES SQUARE *Long before it became a symbol of Manhattan's hectic pace, the intersection where Seventh Avenue crosses Broadway (right) was once a quieter place. Two creeks met here in a red maple swamp and fed a beaver pond.*



Of all the visitors
to New York City
in recent years, one
of the most surprising
was a beaver named
José. No one knows

exactly where he came from. Speculation is he swam down the Bronx River from suburban Westchester County to the north. He just showed up one wintry morning in 2007 on a riverbank in the Bronx Zoo, where he gnawed down a few willow trees and built a lodge.

"If you'd asked me at the time what the chances were that there was a beaver in the Bronx, I'd have said zero," said Eric Sanderson, an ecologist at the Wildlife Conservation Society (WCS), headquartered at the Bronx Zoo. "There hasn't been a beaver in New York City in more than 200 years."

During the early 17th century, when the city was the Dutch village of New Amsterdam, beavers were widely hunted for their pelts, then fashionable in Europe. The fur trade grew into such a lucrative business that a pair of beavers earned a place on the city's official seal, where they remain today. The real animals vanished.

That's why Sanderson was skeptical when Stephen Sautner, a fellow employee at WCS, told him he'd seen evidence of a beaver during a walk along the river. It's probably just a muskrat, Sanderson thought. Muskrats are more tolerant of stressful city life. But when Sautner and he climbed around a chain-link fence separating the river from one of the zoo's parking lots, they

found José's lodge right where Sautner had said it was. When they returned a couple of weeks later, they ran into José himself.

"It was just getting dark," Sanderson said. "We were standing on the riverbank shooting the breeze, when all of a sudden we saw the beaver. He swam right up to us, then he started doing circles in the river. We backed up a little, and he did that beaver alarm call with his tail, slap, slap against the water. So we decided we'd better take off."

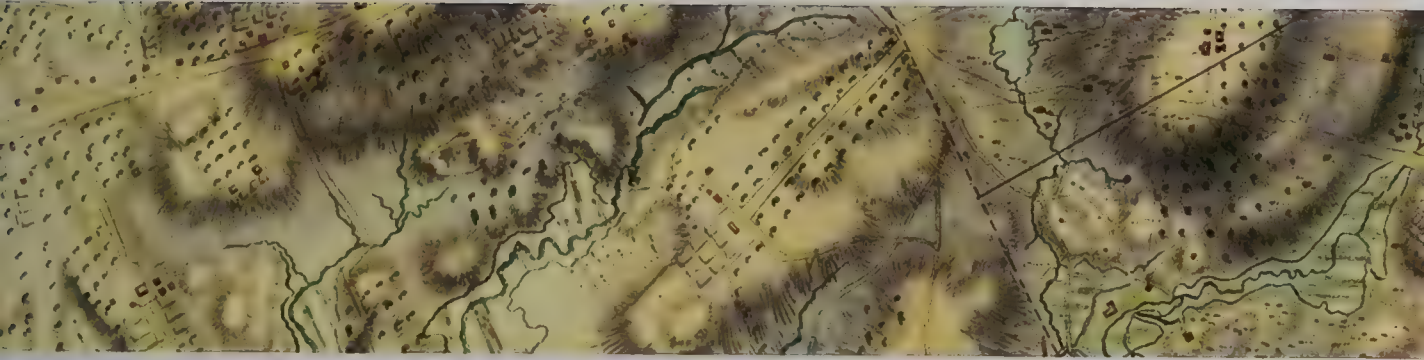
The beaver's return to the Big Apple was hailed as a victory by conservationists and volunteers who'd spent more than three decades restoring the health of the Bronx River, once a dumping ground for abandoned cars and trash. José was named in honor of José E. Serrano, the congressman from the Bronx who'd pushed through more than \$15 million in federal funds over the years to support the river cleanup.

For Sanderson, José's story meant something more. For almost a decade he has led a project at WCS to envision as precisely as possible what the island of Manhattan might have looked like before the city took root. The Mannahatta Project, as it's called (after the Lenape people's name for "island of many hills"), is an effort to turn back the clock to the afternoon of September 12, 1609, just before Henry Hudson and his crew sailed into New York Harbor and spotted the island. If people today could picture what a natural wonder Hudson had looked upon, Sanderson figured, maybe they'd fight harder to preserve other wild places. "I wanted people to fall in love with New York's original landscape,"

BY PETER MILLER

PHOTOGRAPHS BY ROBERT CLARK

ART BY MARKLEY BOYER
AND PHILIP STRAUB



A detail from an 18th-century map of Manhattan Island shows orchards and a farm on Murray Hill (at right).

he said. “I wanted to show how great nature can be when it’s working, with all its parts, in a place that people normally don’t think of as having any nature at all.”

Long before its hills were bulldozed and its wetlands paved over, Manhattan was an extraordinary wilderness of towering chestnut, oak, and hickory trees, of salt marshes and grasslands with turkey, elk, and black bear—“as pleasant a land as one can tread upon,” Hudson reported. Sandy beaches ran along stretches of both coasts on the narrow, 13-mile-long island, where the Lenape feasted on clams and oysters. More than 66 miles of streams flowed through Manhattan, and most of them sheltered a beaver or two—making José’s appearance, in Sanderson’s eyes, a rare glimpse of the way things used to be.

“You might find it difficult to imagine today, but 400 years ago there was a red maple swamp right here in Times Square,” he said one day not long ago, as he waited for the light to cross Seventh Avenue. Dressed in black jeans and a Windbreaker, he didn’t look much different from the tourists beside him on the curb. But unlike them, in his mind he was following a trail along a swampy creek that disappeared beneath the entrance to the Marriott Marquis Hotel at the corner of Broadway and West 46th Street. “Just over there was a beaver pond,” he said, as a bus rumbled by. “It would have been a good place for deer, wood ducks, and all the other animals associated with streams. Brook trout probably, as well as eels, pickerel, and sunfish. It would have been much quieter, of course, although today’s not so bad.”

Sanderson conceived the Mannahatta Project one evening in 1999, after buying a coffee-table book of historical maps of the city. A recent transplant to New York from northern California, he was curious about how the city had evolved. “The landscape in Manhattan is so transformed, it makes you wonder what was here before,” he said. “There are views in this city where you cannot see, except for a person or maybe a dog, another living thing. Not a tree or a plant. How did a place become like that?”

One map in particular caught his eye: a beautifully colored print from 1782 or 1783 that showed the hills, streams, and swamps as well as roads, orchards, and farms on the entire island—something no other contemporary map had done. More than ten feet long and three feet wide, the map had been created by British military cartographers during the eight-year occupation of New York during the American Revolution. Later called the “British Headquarters Map,” it showed the island’s topography in unusual detail because British officers needed that information to plan their defense of Manhattan. To Sanderson the map presented a unique opportunity to strip away the city’s skyscrapers and asphalt and look at least partway back to the island’s original landscape.

What would happen, he wondered, if he laid a street grid of today’s city over this 18th-century rendering? Would anything line up? To find out, Sanderson enlisted family and friends, starting with his wife, Han-Yu Hung, and their young son, Everett, to join him on weekend expeditions to

(Continued on page 136)

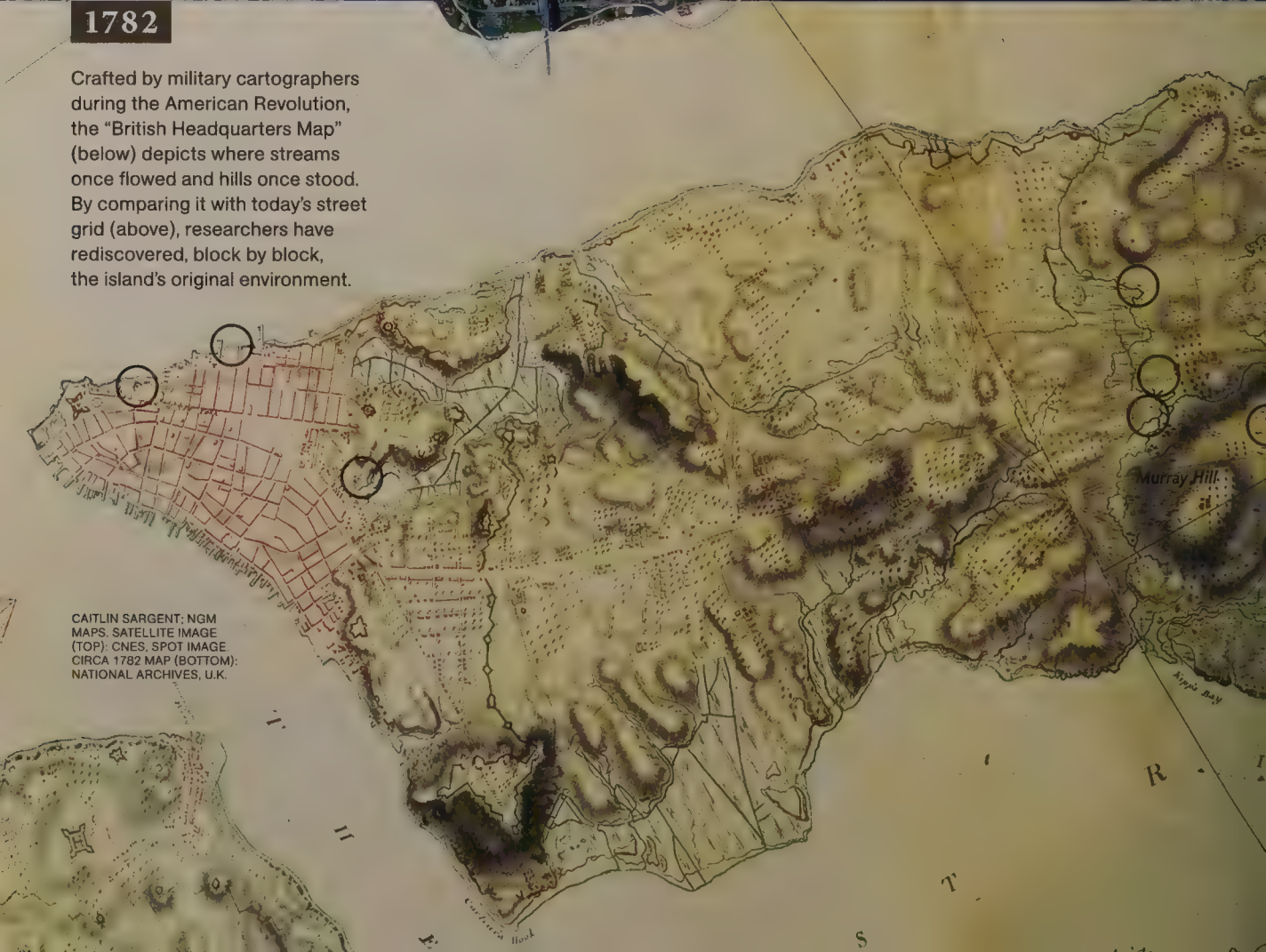
Late 18th-century shoreline
of southern Manhattan
(MAP BELOW)

Beneath New York

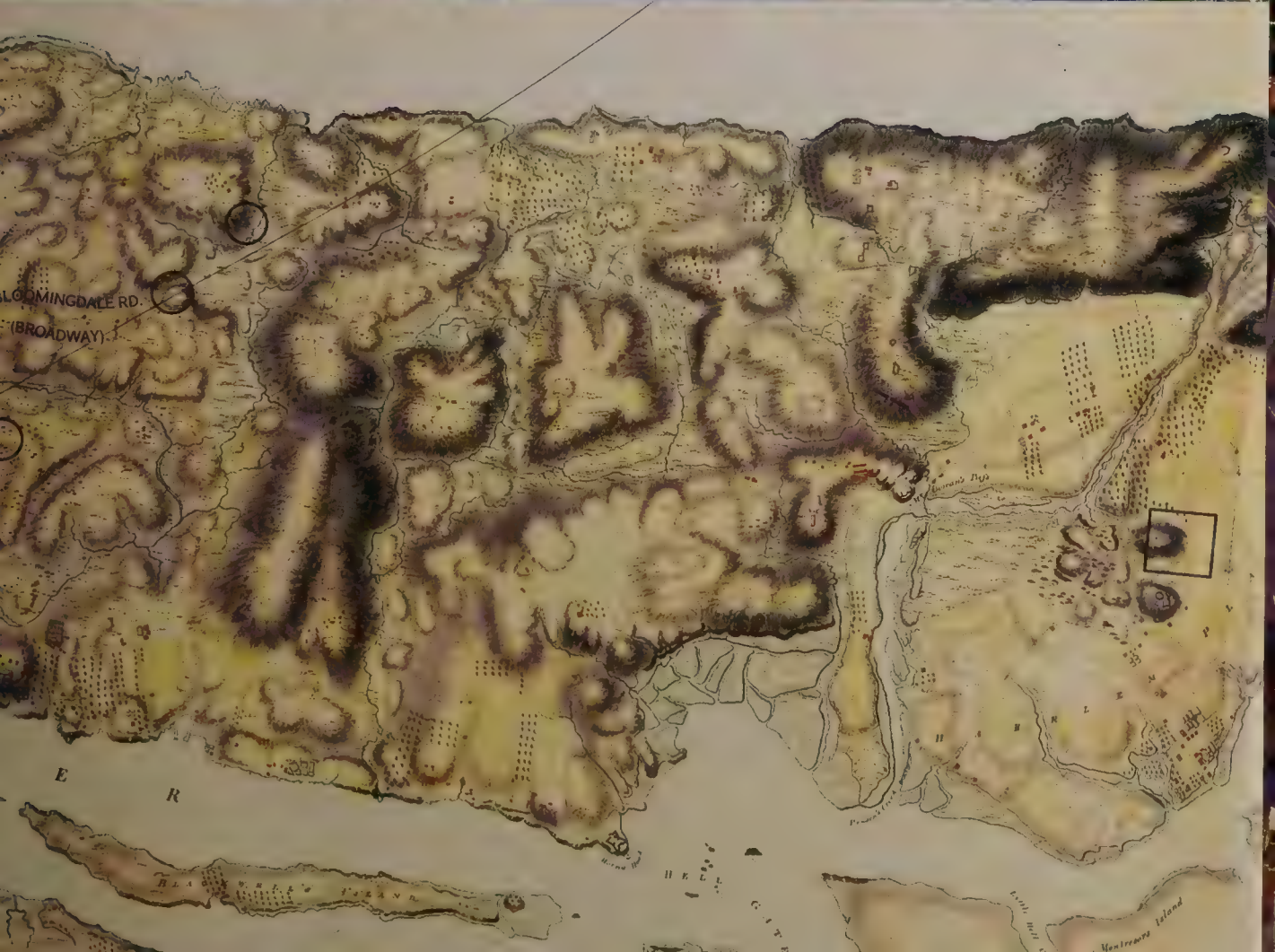
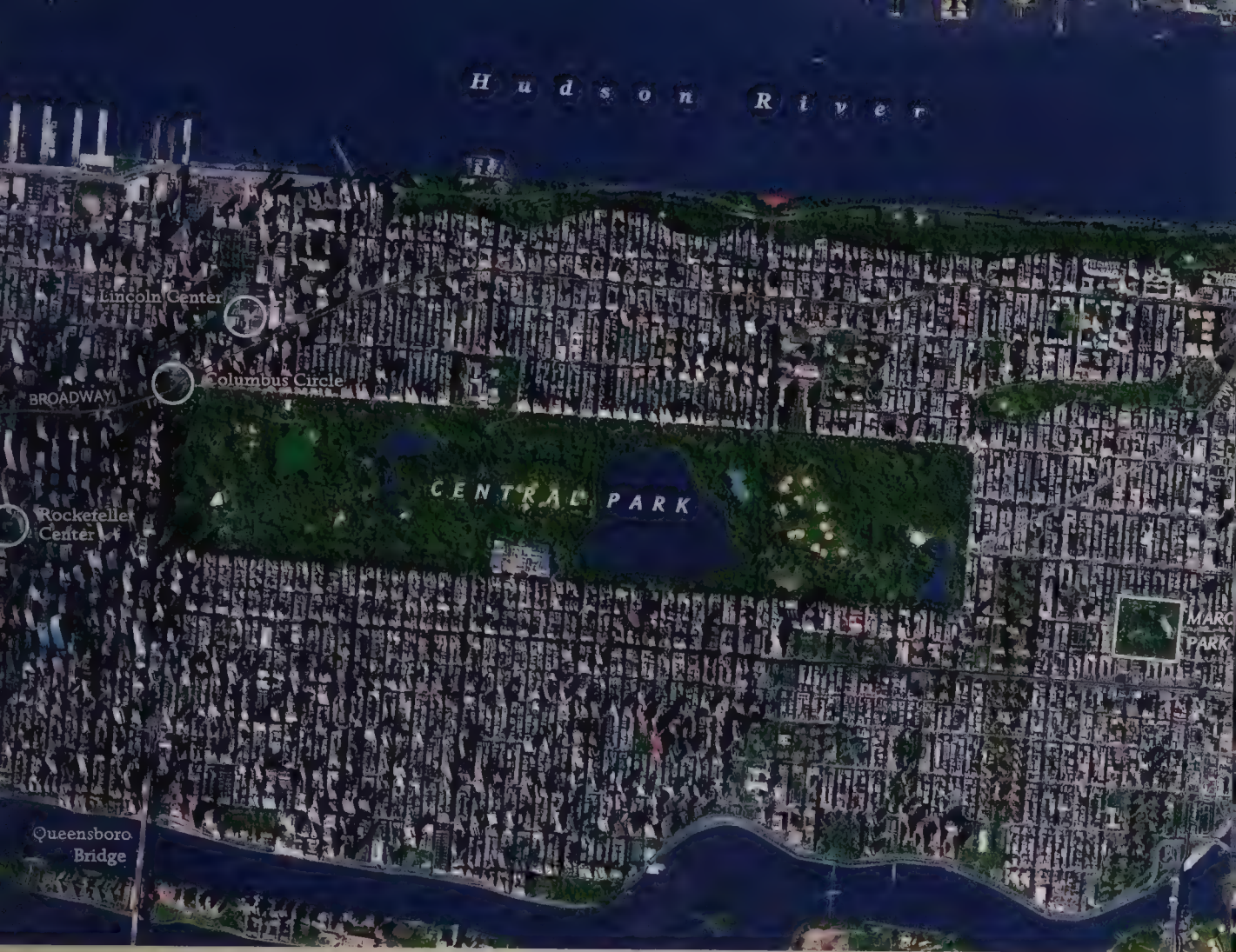


TODAY
1782

Crafted by military cartographers during the American Revolution, the "British Headquarters Map" (below) depicts where streams once flowed and hills once stood. By comparing it with today's street grid (above), researchers have rediscovered, block by block, the island's original environment.



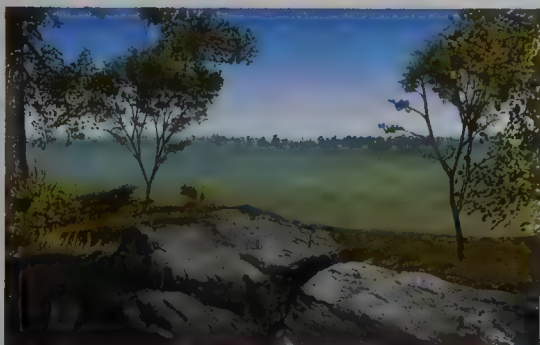
CAITLIN SARGENT: NGM
MAPS. SATELLITE IMAGE
(TOP); CNES, SPOT IMAGE,
CIRCA 1782 MAP (BOTTOM);
NATIONAL ARCHIVES, U.K.



Manhattan was an extraordinary wilderness of towering chestnut, oak, and hickory trees, of salt marshes and grasslands with turkey, elk, and black bear.



HUDSON RIVER *Jeffrey's Hook, at the narrowest spot between Manhattan and New Jersey, was a crossing point for Native Americans centuries ago (left). Today the Little Red Lighthouse, made famous by a children's book, stands beneath the George Washington Bridge.*



HARLEM PLAINS *The Lenape people may have used fire to keep open this grassy plain (left) for hunting deer and other game. The same bedrock that jutted through the ground in 1609 can still be seen today in Harlem's Marcus Garvey Park (right).*



FOLEY SQUARE *The Collect Pond sustained Lenape villagers before becoming the main freshwater supply for Dutch and English settlers. Polluted by a tannery, the pond was buried under slums later cleared to build the square.*

ART: PHILIP STRAUB



(Continued from page 127) visit places on the map that still existed. Trinity Church in Lower Manhattan, for one, was founded in the late 17th century. A typical grave marker in the church cemetery reads, "Here Lyeth the Body of John Abrell Who Departed this Life Jan the 10th 1762 Aged 40 Years." Since the cemetery can be located on both the "British Headquarters Map" and today's street grid, Sanderson was able to push a virtual pin, so to speak, through both maps by taking a GPS reading at the site and attaching it to a digitized version of the older map. After repeating this process at 200 or so places, sticking in pin after pin, he and his team succeeded in matching the "British Headquarters Map" to today's city grid with an accuracy of half an uptown block, or roughly 130 feet. For Sanderson this added a whole new dimension to the modern city's landscape. He could now stand at any spot in Manhattan and picture, more or less, what had been there in 1782.

Take the gentle rise of Fifth Avenue as you walk past the New York Public Library. "There's a reason you can stand on the sidewalk here and see the tops of people's heads a few blocks away," Sanderson said. "This was near the top of Murray Hill, where the Murray family had a farm and orchard in 1782. During the battle for New York, the British landed at Kips Bay on the East River and marched up here, cutting off half of Washington's army, which was trapped in Lower Manhattan. There's a legend that Mrs. Murray offered tea to the British officers. So they stopped here at the farm, and while they were having tea, Washington's troops slipped past them on the Bloomingdale Road, which is now Broadway, and escaped."

As fascinating as the "British Headquarters Map" was, Sanderson didn't want to stop his time machine at 1782. He wanted to go all the way back to 1609. So he and his colleagues stripped from the map all the features that had

been added by settlers and soldiers—such as roads, farms, and fortifications—until they'd reduced their digitized version of the map to the basic building blocks of the physical landscape: shorelines, hills, cliffs, land cover, streams, and ponds. As a landscape ecologist, Sanderson was used to taking apart wild places conceptually to understand how they work, separating a rain forest in Gabon, say, into geological, hydrological, ecological, and cultural layers. Now he and his colleagues set out to build a landscape from the bottom up, starting with the terrain and filling it with all the plants and animals that were likely to have lived there.

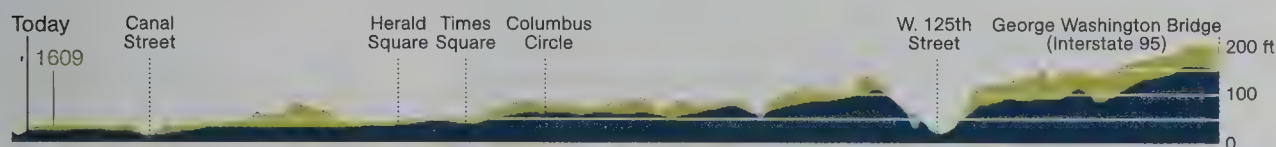
They began by listing the various ecosystems they could safely assume existed on the island, such as old-growth forests, wetlands, or plains, based on soil types, rainfall, and so on. Because it was located at the intersection of geographic regions, Manhattan probably had not only spruce trees from the northern forests but also magnolias from the southern forests, migratory birds from nearby flyways, and even tropical fish from the Gulf Stream during summer. In all, they identified 55 different ecological communities. "It was an incredibly diverse place," Sanderson said. "If the island had stayed the way it was back then, it could have become a national park like Yosemite or Yellowstone."

Once they identified the island's ecosystems, they could fill in the wildlife. But which animals lived where? To be as precise as possible, Sanderson's group took their research a step further. For each species they identified essential habitat requirements. A bog turtle, for example, needed a wet meadow, insects, and a sunny place to warm itself, while a bobcat needed rabbits and a den site in which to raise its young. "We just kept asking ourselves, What does this need? What does this need? What does this need?" Sanderson said. Then they compiled a list for each species. As they built their database, they discovered a dense network of relationships among species, habitats, and ecosystems on the island, not unlike the complex social networks that people create.

Peter Miller is a senior editor. Robert Clark's photographs of Angkor appeared in the July issue. This is the first time that work by Markley Boyer or Philip Straub has been published in the magazine.

Sanderson called this network a Muir web, after American naturalist John Muir, who once noted that “when we try to pick out anything by itself we find that it is bound fast by a thousand invisible cords that cannot be broken, to everything in the universe.” Sanderson and his team, in a sense, were trying to make those thousands of cords visible.

Consider a beaver that lived at Times Square



BULLDOZING BROADWAY A cross section of the island along the avenue shows how much of the landscape was leveled to build the city.

in 1609. If you grabbed him by the scruff of his neck and lifted him out of the web, you’d find lines connecting him to a slowly meandering stream, to the aspen trees he ate, and to the mud and twigs he used to build a lodge. Not only that, you’d also find lines to the bobcats, bears, and wolves that depended on him as prey and to the frogs, fish, and aquatic plants that lived in the pond he helped to create. “The beaver, it turns out, is a landscape architect, just like people,” Sanderson said. “You need him to flood the forest, which kills the trees that attract the woodpeckers that knock out cavities that wood ducks use for shelter.” Lifting a beaver out of the web disrupts scores of other residents, which demonstrates how important it can be to think about an ecosystem as a network.

By the time Sanderson and his team had finished compiling their database, they’d put together one of the most detailed scientific reconstructions of a landscape ever attempted, identifying 1,300 or so species and at least 8,000 relationships linking them to one another and their habitats. This was somewhat ironic, Sanderson admitted, since it described a place that didn’t exist anymore. But the same methods that created a portrait of Mannahatta could be applied to wild places today, such as the Greater

Yellowstone region, the Congo forest, or the eastern steppes of Mongolia. If scientists have a model of how a landscape and species interact, they can better predict the impact of climate change, hunting, or other disruptive factors.

For the Mannahatta Project, the next step was to turn all of these data into realistic 3-D scenes, like the one you see at the top of page 122. Sanderson’s goal, from the start, had been

to show what any spot in today’s city—say, the taxi stand on Seventh Avenue in front of Madison Square Garden—looked like 400 years ago. (It was a marsh at the edge of a forest.) To make that happen, Markley Boyer, a visualization specialist, used 3-D modeling software to populate each digitally created scene, block by block, with the right mix of oaks, hickories, streams, ponds, and marshes according to the Muir web database. “We’re basically using the same kind of 3-D software they use in Hollywood to create digital armies marching across a plain,” Boyer said, “only we’re generating tens of thousands of trees in appropriate proportions for each forest type.” Visitors to themannahattaproject.org can give the time machine a try by entering any address in Manhattan to see what that block looked like way back when.

As New Yorkers this month mark the 400th anniversary of Hudson’s visit, Sanderson hopes his project, which has grown to include more than 50 historians, archaeologists, geographers, botanists, zoologists, illustrators, and conservationists from the WCS and other institutions, will stimulate a new curiosity about what existed on Manhattan before the explorer arrived. “I’d like every New Yorker to know that they live in a place that had this fabulous ecology,” he said. “That New York isn’t just a place of fabulous art, music, culture, and communications, but also a place of amazing natural potential—even if you have to look a little harder here.” □



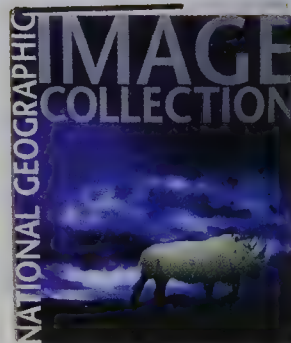
ON ASSIGNMENT King Fever Working for five months on a wet, windy island with the pervasive smell of penguin waste may sound like a nightmare, but it was Stefano Unterthiner's dream come true. As a child in Italy he'd seen a film about the southern Indian Ocean's Crozet archipelago and for years longed to document its wildlife. His chance came in December 2006 when he was sent there on assignment—his first for this magazine—to shoot this month's king penguins feature. Now, with his goal accomplished and more than 25,000 pictures to show for it, Unterthiner (above, on Possession Island) remains spellbound by the region: "I've never stopped wondering, and I've never stopped dreaming."

IN MEMORIAM Bart McDowell In 1974 in Soviet Georgia, Bart McDowell came to eat at a Tbilisi tavern—and left with gifts and a tale of dodging toasts to Stalin. He wove the story into one of five books (and more than 30 articles) he wrote in 32 years as



a *Geographic* writer and editor. At the Vatican, subject of another book, he (left, at left) and photographer Jim Stanfield had remarkable access. Bart, who died this year, was a remarkable man. As a friend said, "He seemed incapable of writing a bad sentence."

Society Updates



NG BOOKS

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GeoPuzzle Answers

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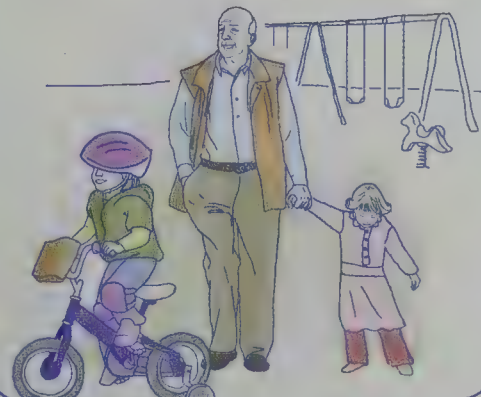


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John and Shirley Spinelli included National Geographic in their estate plans.



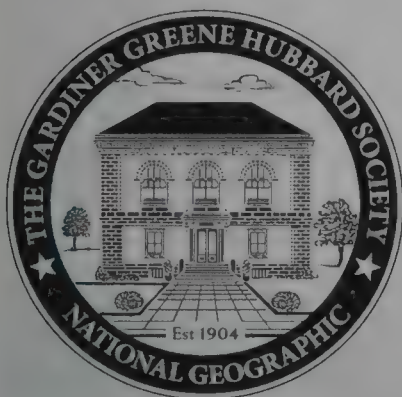
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"We believe in the work of National Geographic and wanted to be involved," says John Spinelli. He and his wife Shirley grew up reading *National Geographic* magazine and passed that love on to their children and grandchildren. Now retired, they enjoy in-line skating, tennis and bird watching.

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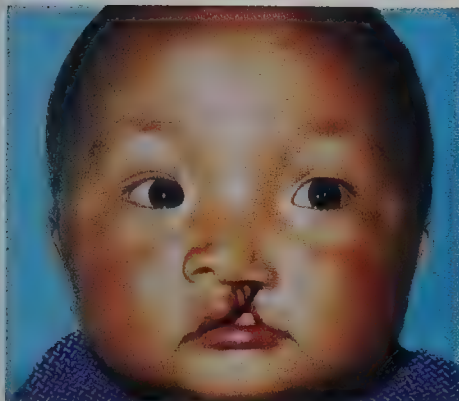
Smoking Hot Sunlight focused on a reflective disk bounces back enough heat to light a cigarette in Phoenix, Arizona. This solar-cooker demonstration, part of the World Symposium on Applied Solar Energy, was one of 85 displays from 50 exhibitors on the grounds of the Phoenix Public Library in the fall of 1955. Some 29,000 people came to marvel at sun-powered sights, from electricity generation to furnaces to baking cinnamon rolls. But the Cold War may have prevented a warm welcome for visiting Russian solar scientists. "The Soviet exhibit created a few questions," note the photographer's captions. "There appeared neither the scheduled exhibit or exhibitor." —Margaret G. Zackowitz

➤ **Flashback Archive** Find all the photos at ngm.com.

PHOTO: BOB TOWERS, NATIONAL GEOGRAPHIC STOCK

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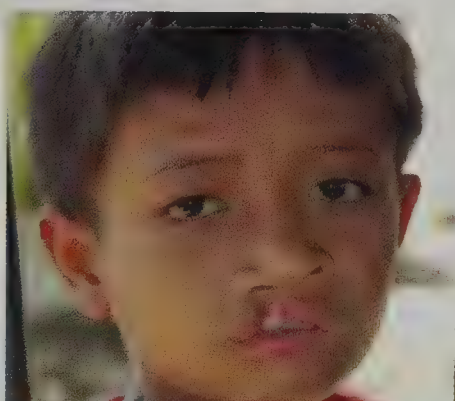
Each Of These Kids Needs Somebody Who Cares Enough To Send \$250. Once.



Ming, 6 months, China



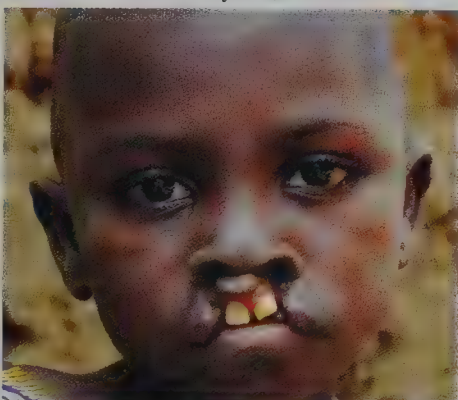
Shiva, 1 year, India



Mot, 13 years, Cambodia



Durgap, 5 years, India



Funmi, 8 years, Nigeria



Salazar, 5 years, Philippines

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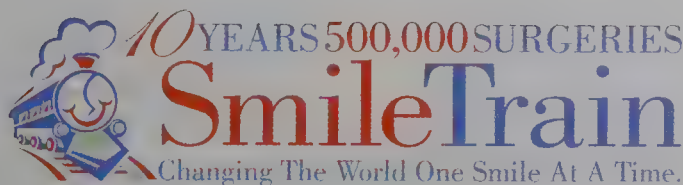
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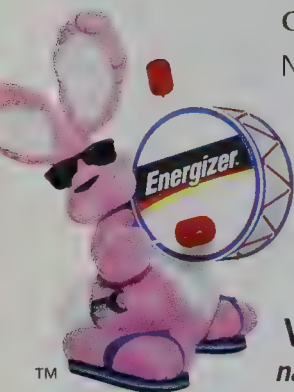
Donate online: www.smiletrain.org or call: 1-800-932-9541



A Healthy Diet During Pregnancy Can Help Prevent Birth Defects And Clefts. Diet is an important part of pregnancy. Eat a healthy diet that contains lots of fruits and vegetables and foods fortified with folic acid. According to the U.S. Government, women who plan to have a child should be sure to take sufficient levels of folic acid (400 micrograms per day) during pregnancy to help prevent neural tube defects and reduce the risk for cleft lip and palate. When folic acid is taken one month before conception and throughout the first trimester, it has been proven to reduce the risk for neural tube defects by 50 to 70 per cent. Be sure to receive proper prenatal care, quit smoking, and follow your health care provider's guidelines for foods to avoid during pregnancy. For more information, visit www.SmileTrain.org. The Smile Train is a 501 (c)(3) nonprofit recognized by the IRS, and all donations to The Smile Train are tax-deductible in accordance with IRS regulations. © 2009 The Smile Train.

world beat

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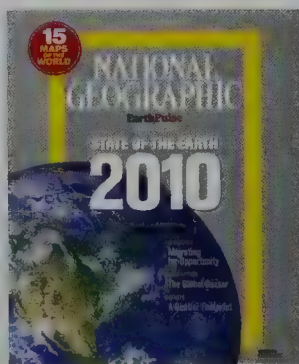
What if church wasn't just a place we go, but something we do? A menu of adventure. An active verb, instead of a noun. What if church wasn't just a building, but thousands of doors? Whoever knocks might find a journey to call their own.

**RETHINK
CHURCH**
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TAKING THE PULSE OF THE PLANET



EarthPulse: State of the Earth 2010 special collector's edition uses dynamic photography, maps, graphs, and analysis to examine the crucial trends transforming our planet. Our future depends on understanding these trends and gaining true

perspective on the possibilities that lie ahead.

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DESFILE DE BOYEROS



Declared a "masterpiece of the oral and intangible Heritage of Humanity" by UNESCO, Costa Rica's "Desfile de Boyeros" is a

traditional parade. Oxcart workers from all over the country travel into the capital, San José, to celebrate and display their beautifully hand-painted carts. "Desfile de Boyeros" takes place November 29–30, 2009.

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Legal Notice

If You Are a Licensed Driver or Own a Motor Vehicle A Proposed Class Action Settlement May Affect Your Rights

Para Una Notificación En Español, Llame O Visite Nuestro Website www.dppasettlement2.com

There is a Proposed Settlement in a class action lawsuit, *Fresco, et al. v. R.L. Polk & Co. and Acxiom Corp.*, Case No. 07-cv-60695-JEM, in the U.S. District Court for the Southern District of Florida.

The Proposed Settlement affects a "Class," or group, of people that may include you. This is just a summary of your rights. To get complete information you should visit www.dppasettlement2.com or call 1-866-397-0925.

What Is the Case About?

The people who filed this lawsuit, the Plaintiffs, claim that the Defendants knowingly obtained, used, or disclosed personal information from motor vehicle records in violation of a federal law, the Driver's Privacy Protection Act ("DPPA").

The companies that were sued, the Defendants, don't think they did anything wrong. They agreed to the Proposed Settlement to avoid the further expense, inconvenience, and burden of this litigation.

Who Is Involved?

The Class includes all persons whose Personal Information or Highly Restricted Personal Information (as those terms are defined by the DPPA) was obtained, used or disclosed by either of the Defendants from April 1, 1998 through the date that the Court approves the Final Order.

The Defendants are: R.L. Polk & Co. and Acxiom Corporation.

What Does the Settlement Provide?

The relief provided is injunctive. This means that the Defendants have agreed to design, implement, and maintain specific, substantial procedures to enhance compliance with the DPPA when they obtain, use, or disclose information regulated by the DPPA. There will be no monetary recovery for Class Members. However, if you have actual money damages, you can file a lawsuit on your own.

Who Represents Me?

The Court has appointed attorneys to represent the Class. Class Counsel will request that the Court award attorneys' fees and expenses in an amount not to exceed \$7.5 million. You may hire your own attorney, if you wish. However, you will be responsible for your attorney's fees and expenses.

What Are My Legal Rights?

If the Court approves the Proposed Settlement, you will be bound by the Court's decisions. You will not be able to sue the Defendants for the claims that were made in this lawsuit, including claims for statutory liquidated damages. But you will be able to sue for actual money damages in an individual lawsuit. For full information about the rights you are giving up, please read the *Notice of Proposed Class Action Settlement*.

You Can Tell the Court if You Do Not Like the Proposed Settlement.

To object or comment, you must send a letter that is mailed and postmarked no later than October 9, 2009, as outlined in the *Notice of Proposed Class Action Settlement*. If you employ a lawyer to prepare the objection, then the objection letter must include a section detailing the lawyer's experience with class actions. The section must specifically list the capacity in which the lawyer participated in each class case (e.g. plaintiffs', defendants', or objectors' counsel) and the outcome of each class case. If the lawyer represented objectors in a class case, then the lawyer must detail the disposition or effect that the objection had on each class case. Please note that even if you employ a lawyer to prepare the objection, you must still personally sign the objection letter. By signing the objection letter, you are attesting that you discussed the objection with the lawyer and have fully reviewed the objection letter.

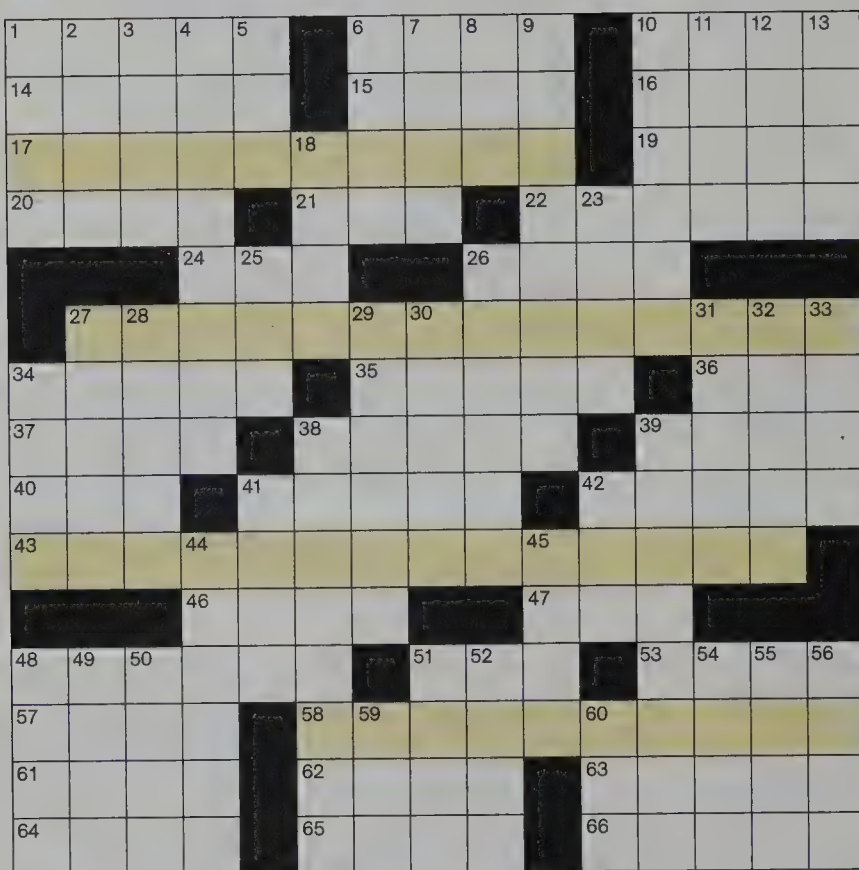
Will the Court Approve the Proposed Settlement?

The Court will hold a Final Approval Hearing on December 7, 2009 at 10:00 a.m. to consider whether the Proposed Settlement is fair, reasonable, and adequate and to consider the motion for attorneys' fees and expenses. If comments or objections have been received, the Court will consider them at this time.

For more information on the Proposed Settlement, and to get a copy of the *Notice of Proposed Class Action Settlement*, call 1-866-397-0925, visit www.dppasettlement2.com, or write DPPA Settlement Administrator, c/o The Garden City Group, Inc., P.O. Box 9000, #6520, Merrick, NY 11566-9000.

1-866-397-0925
www.dppasettlement2.com

GEOPUZZLE



Wily Orchids

Puzzle by Cathy Allis

Orchids and crossword puzzles have something in common. Both practice trickery. The story on page 100 looks at the games orchids play with their pollinators. Tinted puzzle clues have a little fun with the flimflamming flowers.

ACROSS

- 1 Riffles (through)
- 6 *Dracula* orchid's emission
- 10 Bucket orchid's bucket, to male euglossine bees
- 14 Musical Previn or Watts
- 15 Star orchid of Madagascar's nectar, to a hawk moth
- 16 Pore
- 17 With 58 Across, how many an orchid's pollen sac ends up "flying"?
- 19 Computer menu heading
- 20 Verbal disrespect
- 21 Product of Santa's workshop
- 22 High-tech trash
- 24 Saharan
- 26 Income sources for sr. folk
- 27 Get a pollen sac stuck to oneself, à la orchid bee?
- 34 French author of *The Plague*
- 35 Passageway for a stray
- 36 Marauder of yore
- 37 Subj. in which you learn your parts
- 38 Chord such as C-E-G
- 39 Horizontal kin of ■ Dagwood
- 40 Chicken or chair piece
- 41 Memento
- 42 Organ with a beat

- 43 Like orchids, thanks to natural selection?
- 46 Societal troubles
- 47 Prefix with cellular
- 48 More furious
- 51 _ arabic (acacia tree output)
- 53 Marks on some scores, or some scores
- 57 Suitable for cacti, climatewise
- 58 See 17 Across
- 61 Duck or color
- 62 Bern's river
- 63 Goad
- 64 Azure obscurer
- 65 Does in forests?
- 66 Youth group

DOWN

- 1 Chem class sites
- 2 Celtic one-name singer
- 3 Does sum work
- 4 Kind of orchid corsage that lasts longest
- 5 1/3600 of an hr.
- 6 Miscellany
- 7 Import tax
- 8 Gold, at the Alhambra
- 9 Was a court judge?
- 10 Daddy Warbucks's right-hand man
- 11 Low-light retinal receptors
- 12 Landed
- 13 Rose in Reds history
- 18 Latin words to an assassin
- 23 Like the surface of a bucket orchid
- 25 Authorizes
- 26 Manhattan is one
- 27 Solar _ (rooftop heat absorber)
- 28 Insect's adult stage
- 29 Anoraks and such
- 30 Like the Coneheads
- 31 In the lead
- 32 Spicy mixture in Indian dishes
- 33 Massage target
- 34 Young yak
- 38 Turnpike
- 39 Birthright
- 41 It may be tall
- 42 Chinese dynasty after the Qin
- 44 Form of brainteaser
- 45 A dromedary has one
- 48 Geometry, algebra, and trig
- 49 Geometry calculation
- 50 Mexican dictator Porfirio _
- 51 Actor Richard, Tibet activist
- 52 Pusher's customer
- 54 Pulitzer-winning playwright for *Picnic*
- 55 School founded by Henry VI
- 56 Nine-digit IDs
- 59 Robert Burns denial
- 60 Tennis call

Answers in
Inside Geographic

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THE TALLEST TREES

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CURRENT YR/VOL

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WHERE THERE IS WATER THERE IS LIFE. It is

one of the fundamental principles of planet

Earth. And to insure that it will always

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be so, we are constantly improving desalination

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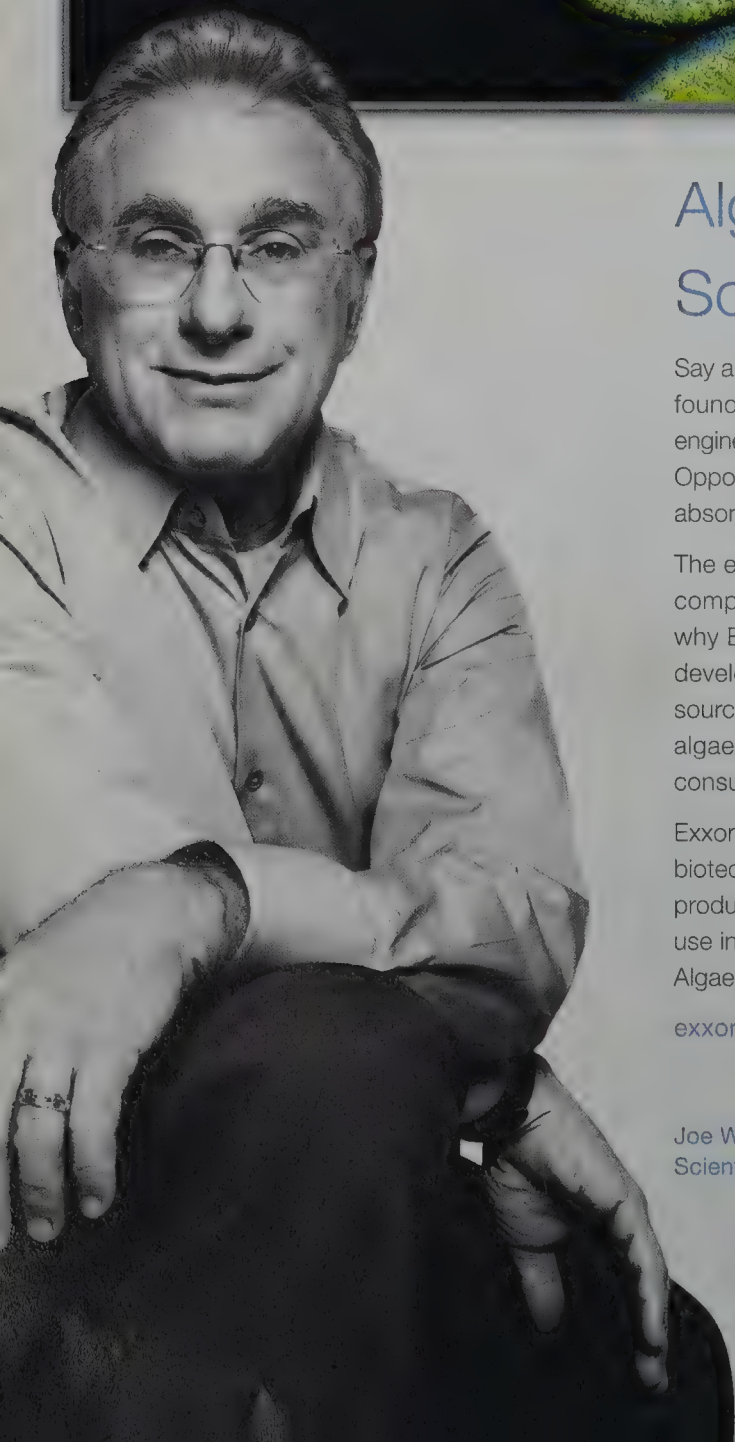
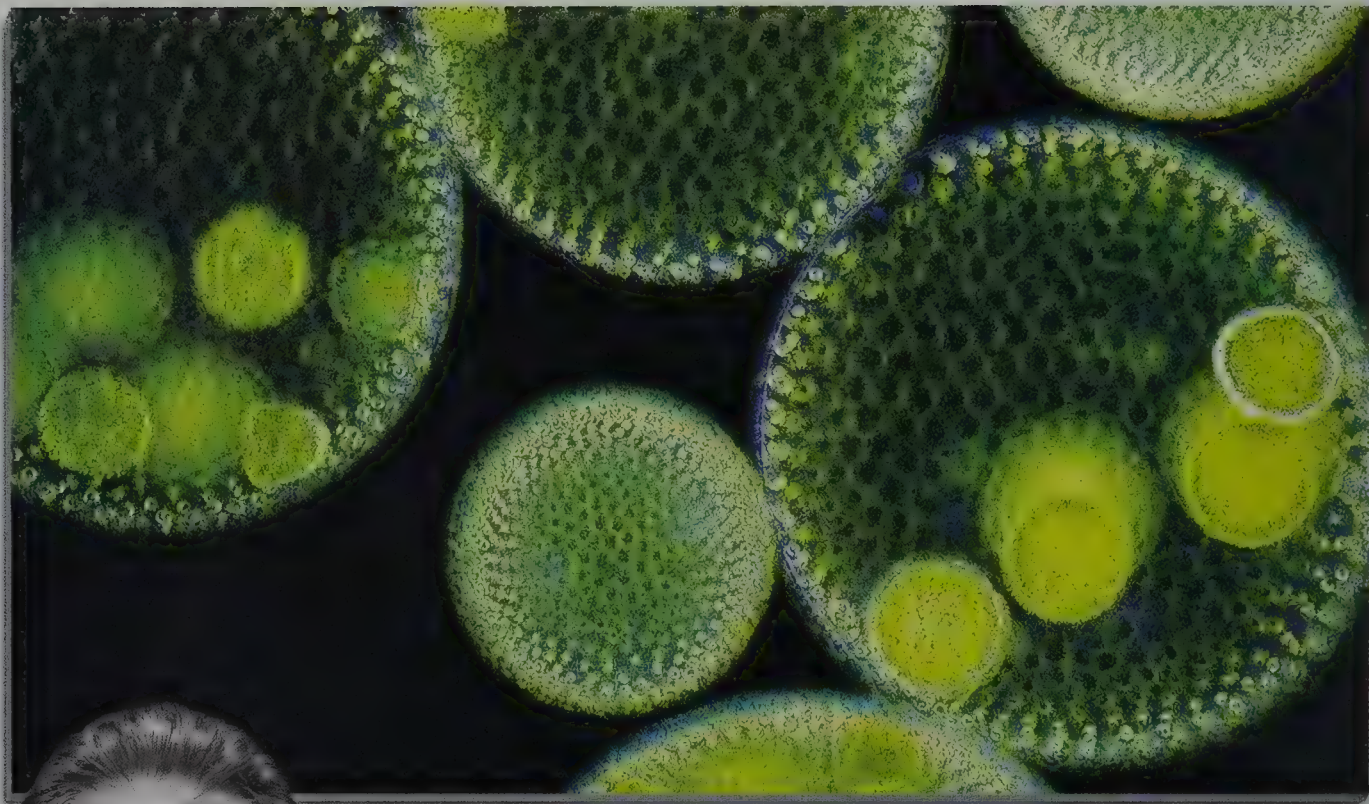
desperately needed by both developing and

developed countries. All the while, the scientist

and the chemist in us, ever mindful of the

elements that hold the answer. Hydrogen.

Oxygen. And Human.



Algae-powered cars: Science fiction or science?

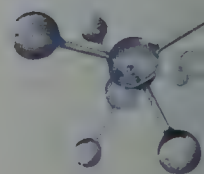
Say algae, and most people think of those unpleasant green organisms found in swimming pools and fish tanks. But to the scientists and engineers of ExxonMobil, algae conjure something far more appealing: Opportunity. Why? Because algae can create renewable energy while absorbing CO₂.

The energy from algae might someday produce biofuels that are compatible with those made from conventional crude oil. That's why ExxonMobil is committed to a major long-term research and development program aimed at developing algae as a viable fuel source. Unlike other biofuel sources such as corn and sugar cane, algae do not compete with our food supply. And because they consume CO₂, algae could help reduce greenhouse gases.

ExxonMobil is partnering with Synthetic Genomics, Inc., pioneers in biotechnology, on this groundbreaking research effort. Our goal is to produce biofuels from algae in the future to supplement the fuels we use in our vehicles today, while reducing greenhouse gas emissions. Algae have never looked so inviting.

exxonmobil.com

Joe Weissman
Scientist



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NATIONAL GEOGRAPHIC

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JAMES NACHTWEY

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If you think a marathon is too easy, try a 125-mile race. In the desert.

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Pumped-Up Pumpkins

Growers are aiming for a 2,000-pounder.

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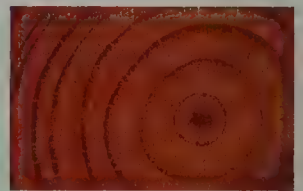
On the Cover

It's part of a portrait made up of 84 shots, taken as cameras rode a rope rigged by canopy ecologist Jim C. Spickler.

Composite image by Michael Nichols



ngm.com



Tree Pedigree

The world's tallest trees are also among the world's oldest. Our interactive time line traces the past on the rings of one redwood from California.

PAUL ZAHLE

On a smarter planet,
the question isn't what can we do.
The question is what will we do?
Let's build a smarter planet.
ibm.com/smarterplanet





Fog blurs the treetops in the Lady Bird Johnson Grove of California's Redwood National Park.

Lying on a soft, damp forest floor, looking up and oblivious of time, I'm in one of the most magical places on Earth, Jedediah Smith Redwoods State Park in northern California. I can hear the panic in my mother's voice as she searches for me—her ten-year-old who has a habit of disappearing in the woods. I should shout out to put her at ease, but not just yet. I want a few more minutes of solitude with the tallest trees I've ever seen.

Six years later, I'm lying on a hard, dusty plywood floor in a house under construction. It's lunchtime on my summer job; I'm resting with my fellow carpenters and looking up at a new redwood ceiling. The beams and boards are stunning, a perfect illustration of why this wood is so coveted and why so many redwood forests are leveled.

In this month's issue you'll meet others who share my fascination with redwoods. Biologist Mike Fay and his hiking partner, Lindsey Holm, spent a year walking and studying the redwood ecosystem from south to north. Joel Bourne writes about their journey and examines the controversies surrounding redwoods, trees with which National Geographic has had a long association.

"California revolutionized the world with the silicon chip," says Fay. "They could do the same with forest management." Could it be that Fay, who's spent decades advocating for African forests, has found the solution to management in the very state he calls home? We hope so.

A handwritten signature in dark ink, which appears to read "Chris Jones". The signature is stylized with a large, sweeping initial 'C'.

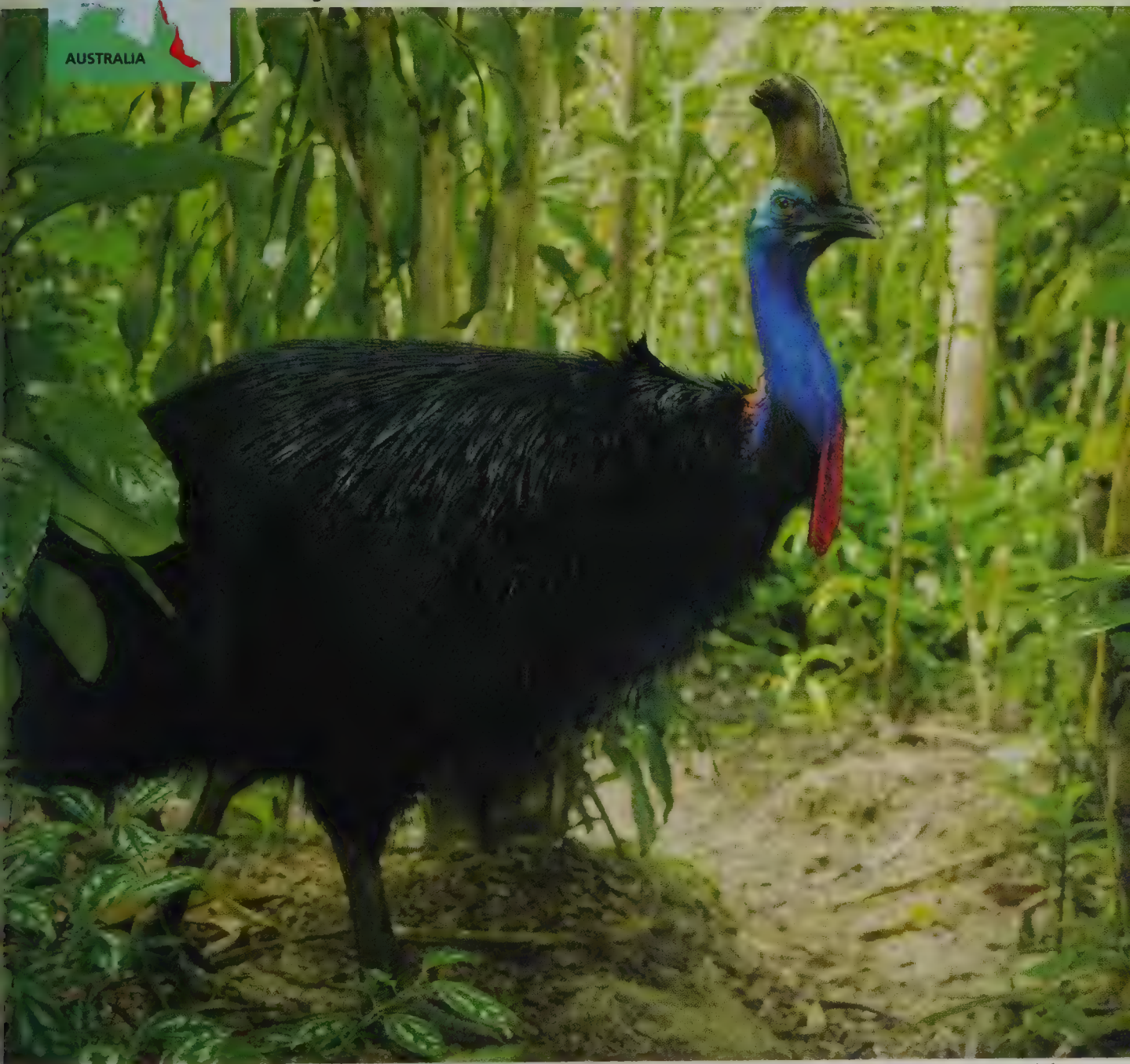


Southern Cassowary (*Casuarus casuarius*)

Size: Head and body length, 102 - 170 cm (40.2 - 67 inches) **Weight:** 29.2 - 58.5 kg (64.4 - 129 lbs)

Habitat: Prefers rainforests, but will also use savanna forests, mangroves and fruit plantations

Surviving number: Estimated at 10,000 - 20,000



Photographed by Kevin Schafer

WILDLIFE AS CANON SEES IT

Why fly? Able to run at speeds exceeding 30 miles per hour and swim expertly, the southern cassowary gets around very well despite being flightless. The solitary bird announces its presence with loud, deep booms that carry remarkably far through the foliage. During breeding season, females mate with one to three males, starting a new nest with each partner, who then incubates the eggs and cares for the chicks. But this cycle of life is being seriously

upset by habitat fragmentation, introduced predators, collisions with vehicles, and hunting. Quick though it is, the southern cassowary cannot outdistance these deadly threats.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.

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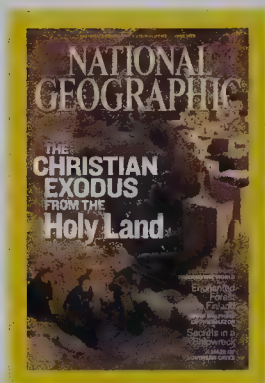
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June 2009

The Forgotten Faithful

I have been covering the Middle East for more than 40 years [the writer is currently a columnist for the Huffington Post] and have written often about the growing plight of the region's Christian communities. I was therefore disturbed by the distorted cover story on the tragedy. Author Don Belt is wrong: Christian difficulties in the Arab world did not commence with the Crusades but rather with the birth of Islam itself. Muhammad's faith has always rejected other faiths. The Prophet's followers preached that "people of the book"—Jews and Christians—could be tolerated as second-class, subjugated dhimmis. But they were never granted equality under Islamic rule. And over the centuries that preceded the Crusades, communities of Jews and Christians were periodically forced into conversion. Second, while the Arab-Israeli conflict continues to overheat the regional atmosphere, the real pressure on Palestinian Christian Arabs—as well as Lebanon, Syria, and Iraq—stems from the heightened power and pressures of radical Islamic

groups, not from Israeli or American policy. In Palestine, Islamist thugs regularly force Christians to sell them their land and businesses—or simply seize them. No one doubts that Israel's security fence/wall causes hardships for Palestinians—both Christian and Muslim. But nowhere does Belt explain that the divider exists as the direct result of Palestinian terrorism. Nor does he point out another fact: While Christian communities in the Arab world continue to disappear (the Christian population of Bethlehem has gone from 90 percent to less than 25 percent; of Lebanon, from 60 percent to 27 percent), the only place in the Middle East where Christian communities are expanding is in the Jewish state of Israel, where since 1949, the number of Israeli Arab Christians has grown by an astonishing 345 percent!

RICHARD Z. CHESNOFF
New York, New York

Author Don Belt responds: When Richard Chesnoff notes that Arab Christian numbers inside Israel have grown "an astonishing 345 percent" since 1949, he includes many thousands of non-Arab Christians who have emigrated from Russia since the 1980s. Israel's indigenous Christian population, while showing a natural increase, has in fact dropped from 2.9 percent of the total Israeli population to 1.7 percent, according to the 2008 Statistical Abstract of Israel. He also blames radical Islam for the modern exodus of Christians from the Palestinian territories. My reporting indicates otherwise. In a recent survey of West Bank Christians by sociologist Bernard Sabella of Bethlehem University,

only 7 percent of respondents cited religious extremism as a reason for leaving, compared with lack of economic opportunity (39 percent), emigration/Jewish settlement (23 percent), and lack of housing (19 percent).

I'm a Palestinian and have lived all my life in Bethlehem. My family includes my wife and five children. I live in one apartment in a house that was on a major road before they built the separation wall. After 2002 the wall closed the road to traffic and tourists who might buy anything. I had a small shop. My shop closed, and my business died. There was no income for my family. The worst part has been the psychological impact on my children. I don't want to leave my house. It is a part of my life. For years I had my successful business. When the wall was built, it separated our home and business from Rachel's Tomb. This started the suffering. Thank you for the article, which tells the world that there are Christians in the Holy Land. Somehow seeing this article gives us hope.

GEORGE ANASTAS
Bethlehem, West Bank

Corrections, Clarifications

June 2009:

Page 10: Stanislaw Jawor's Your Shot photograph does not show a setting moon. It is a predawn rising moon.
Pages 12-13: The tornado shown in Visions of Earth is incorrectly described as backlit.
Page 77: The correct location of the falls pictured is the Jyrävä River.
Page 130: Marion Smith's age is 67.

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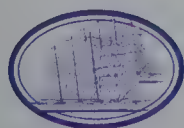
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LETTERS

I truly feel this article was biased against Islam. To blame Muslim Arabs in the Middle East for the exodus of Arab Christians is to ignore Israel. There is barely a mention of this. Scholarly evidence points to Israel as a source of exodus of all peoples in the Levant crescent. No Muslims are targeting Christians in Palestine. These people—Muslim or Christian—are the victims of Israel, period. Also, any good scholar who mentions the brutal Christian Crusades would mention Salah al-Din, a Muslim who kicked out the crusaders. He also returned the battered Jews, Muslims, and Christians and restored their places of

worship. Salah al-Din made sure all three religions were protected. That makes me, as a Muslim, proud. And he only did what Islam taught him to do.

TINA ISSA
Chicago, Illinois

The position of Palestinian Christians in the West Bank has declined rapidly since the PLO took over. Corruption and lawlessness under the Palestinian Authority make opportunities elsewhere more attractive. Of course the Arab-Israeli conflict does not help, but Palestinian Christians are increasingly marginalized and intimidated by neighbors. They can blame Israel because Israel won't

retaliate for criticism. Other Palestinians will. Elsewhere in the Middle East, the plight of Copts and Chaldean Christians is still more tenuous. There is another religious group that has disappeared from Arab lands: Jewish communities.

DORON LUBINSKY
Atlanta, Georgia

The End of Plenty

By American standards our family is struggling financially. In the wake of the economic meltdown, my husband lost his job and now makes less than half of what he made before. With one child in kindergarten and a newborn, we've been under a lot of pressure. After

doing the math, we made the decision for me to stay home, sacrificing our health insurance. The kids have Medicaid. We do without many things we used to take for granted. If my husband hadn't received a lifetime subscription to your magazine as a child, we wouldn't receive it. We reluctantly accept government assistance to feed our family. This morning, I was mired in self-pity and grumbling about the state of our finances. Four out of five meals consist of beans and rice, and I was sick of it. I headed upstairs to nurse the baby. As I settled down with my son in my arms, I turned to the picture on page 36 depicting a starving baby in Ethiopia. My eyes filled with tears of shame. I couldn't help but compare that withered little boy

with the chubby infant on my lap. That boy is no less cherished than my child. I bet if his mother were plunked down in my life, she wouldn't know what to make of her good fortune. She wouldn't have time to complain. She'd be too busy cooking the beans and rice I disdain, planting vegetables in our yard, and feeding her child.

MELISANDE TIMBLIN
Durham, North Carolina

We need to understand that factory farming of animals adds to the problem of starvation rather than diminishes it. The real solutions are increasing vegetarian eating, eliminating subsidies for agriculture, and encouraging population control.

JOELLEN GILCHRIST
Beverly Hills, Michigan

How about we start reducing our dependence on fossil fuels and fertilizers for those overly green lawns? I'd love to see the expansive front lawns of giant houses planted with gardens.

DIANA LAURENITIS
Canton, Massachusetts

Deep Southern Caves

I've had recurring nightmares since childhood related to my only two great fears: drowning and getting stuck in an underground tunnel. Your photographs often trigger strong emotional reactions for me, but the image on pages 138-9 of John Benson wriggling under solid rock through standing water was the first to give me heart palpitations.

KARL NELSON
Arlington, Virginia



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LETTERS

The experience of total darkness and tranquillity and claustrophobia in caves mentioned in your article—all of it is true! Forty-three years ago I was a 23-year-old salesman. A client named Wayne and I decided to take a long weekend trip with my boat to Missouri's Lake of the Ozarks. It was a hot, humid day on the lake when Wayne decided to show our group a cave that he had explored a year before. I was the last of the group to enter and will never forget the claustrophobic feeling of being on my stomach, slithering forward, and wondering how I was going to get out if I had to go backward. However, once I was inside, perhaps a hundred yards, it was cool and calm and quiet. We turned off

our lights, and it was exactly as the article said—total, stygian blackness. No way to see your hand one inch in front of you. Finally, quieted down, I did feel euphoria and total peace. I will never forget it. And I will never do it again. I am a surface guy.

TOM FRASER
Dyer, Indiana

Made in China

The "ornate bronze mirror" in the photograph at the lower right corner of page 115 is actually the *Ba Gua*, or the eight trigrams in Taoist cosmology. It is from the I Ching and represents the ebb and flow of energies in the universe and the law of the sacred or magic turtle. This system is used in feng shui and in aspects of Oriental medicine. It is a

beautiful piece and deserves to be correctly identified.

BARBARA BRANDON SCHWARTZ
Ocala, Florida

River Spirits

My father, who was born in 1908 near Lake Maracaibo in Venezuela, told me about pink dolphins there. He used to play by the lake's beaches back in 1916, before oil was found. He had heard stories about the pink dolphins. They would help sinking swimmers by pushing them to shore. Once the lake starting pumping out its entrails and the tankers invaded the once quiet waters, the pink dolphins disappeared. I am so glad that they still exist in the Amazon, at least for now.

RITA IRIARTE-OSTAPOVITCH
East Hawkesbury, Ontario

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EDITORS' CHOICE

John Neville Nipomo, California

A 63-year-old railroad enthusiast, Neville was visiting Pingdingshan, China, when he saw a woman sifting through train ashes for coal to heat her home. "The irony," says Neville, "is that this is a coal-mining region—coal is everywhere."

Nicholas McElroy Grovetown, Georgia

In New York's Adirondack Mountains, National Guardsman McElroy, 25, spied a boater and thought, "If she paddles into the center of the pond, it would make an amazing picture."



READERS' CHOICE



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VISIONS OF EARTH



United States A kayaker plunges 70 feet into winter water at Washington State's Outlet Falls. His January 2009 descent was one of only five tallied on the Klickitat River tributary, here swollen by floods and sallow from runoff.

PHOTO: JED WEINGARTEN



England At London's Tooting Bec pool, four fancifully attired, color-coded women kick off the Cold Water Swimming Championships. More than 300 bathers, ages 12 to 85, competed and promoted the thrill of the chill.





Switzerland Neither a bird nor a plane, “Jet Man”—aka adventurer Yves Rossy—soars above the Alps on jet-propelled wings during a five-minute, 186-mile-an-hour flight. He has since flown over the English Channel.



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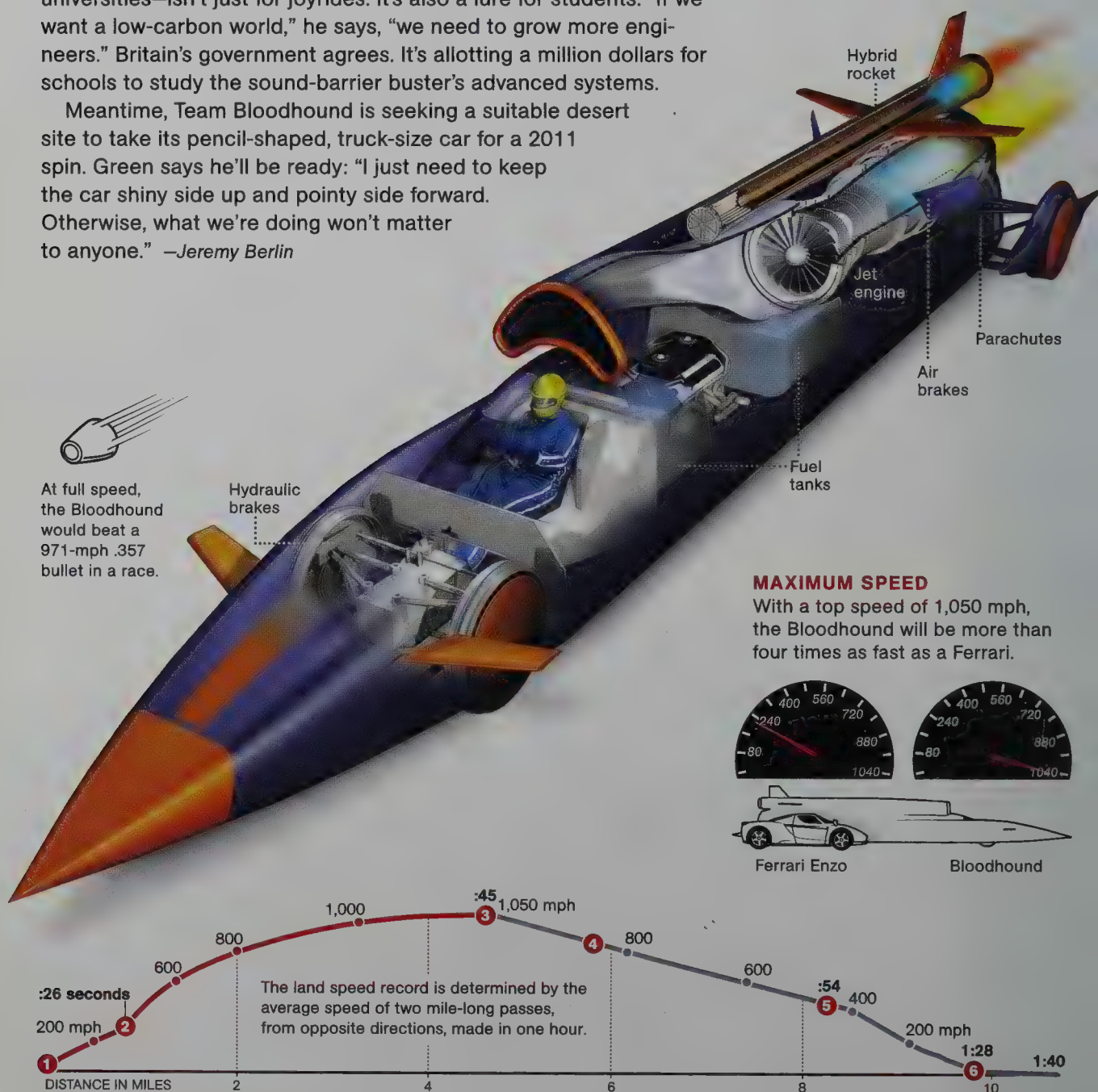
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Green, a Royal Air Force pilot who'll also helm the Bloodhound, says the \$15-million vehicle—funded chiefly by corporations and universities—isn't just for joyrides. It's also a lure for students. "If we want a low-carbon world," he says, "we need to grow more engineers." Britain's government agrees. It's allotting a million dollars for schools to study the sound-barrier buster's advanced systems.

Meantime, Team Bloodhound is seeking a suitable desert site to take its pencil-shaped, truck-size car for a 2011 spin. Green says he'll be ready: "I just need to keep the car shiny side up and pointy side forward. Otherwise, what we're doing won't matter to anyone." —Jeremy Berlin



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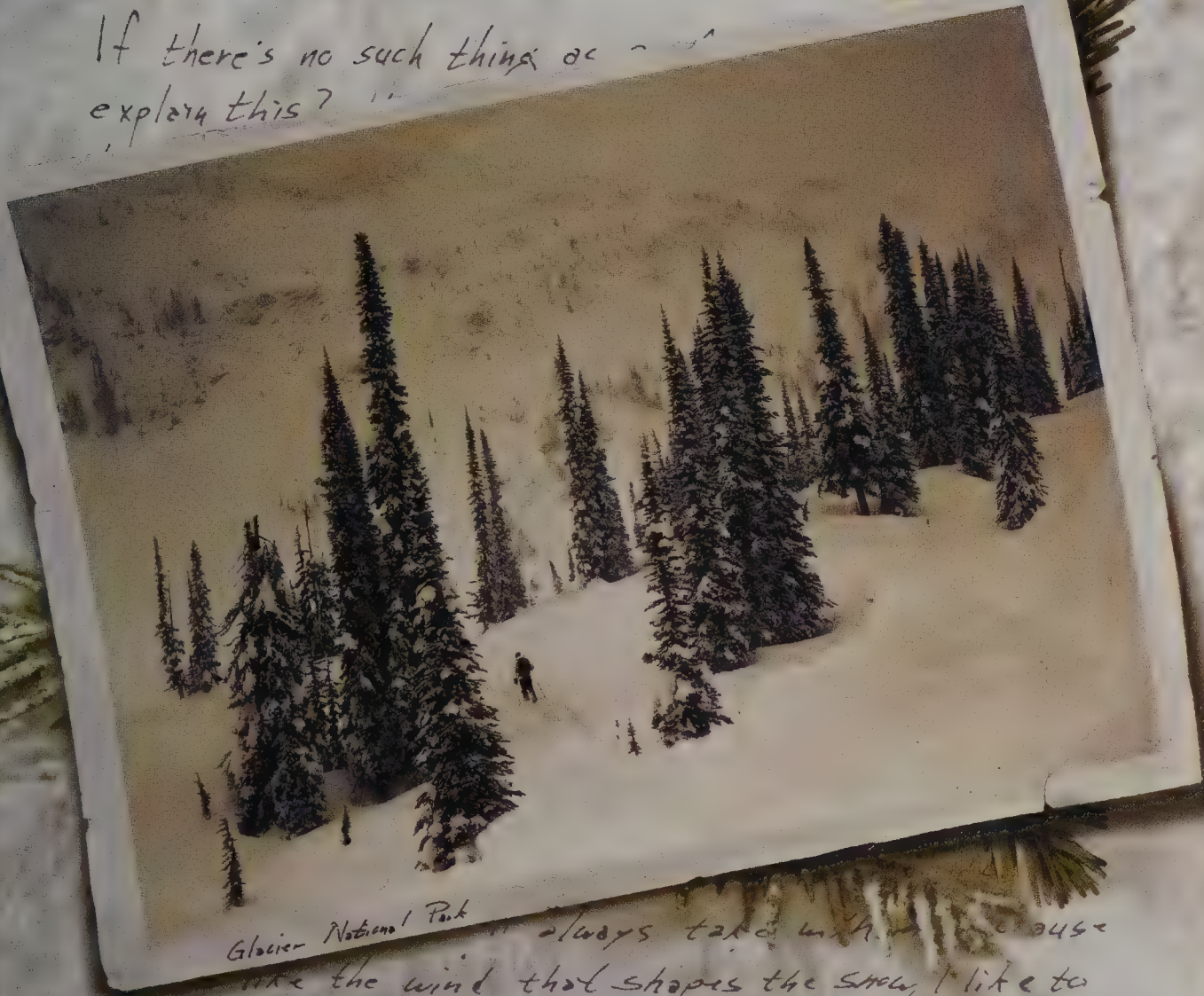
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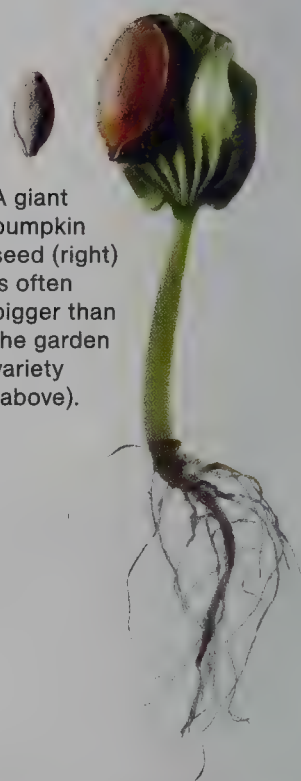
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Pumped Up In the world of giant pumpkins, a 500-pounder is a pip-squeak. “People don’t even blink at ‘em,” says Danny Dill of Howard Dill Enterprises, which sells seeds whose DNA destines them for hugeness. The record is 1,689 pounds, set in 2007. “Within five years,” predicts Dill, “you’ll see a 2,000-pound pumpkin.”

Dill’s late dad was a giant-pumpkin pioneer. In the 1960s the fan of “biggest vegetable” contests fixated on pumpkins—much of their weight is water, so supersizing is relatively easy. Lots of nutrients and water work wonders on the right seed. Today farmers and obsessed amateurs worldwide pollinate a female flower from an apt male bloom and pick one pumpkin per vine to pamper. “My wife says I love the pumpkin more than I love her,” says Jamie Johnson of Arvada, Colorado, who tends his crop an hour each summer night.

After vying for prizes that can hit \$10,000, the gourds become jack-o’-lanterns, compost, even boats for a wacky regatta. Sadly, huge pumpkins aren’t as flavorful as the typical 20-pound specimen. Not that growers mind: They’re in it for the zen of gardening and the thrill of a colossal squash. “I don’t even like pumpkin pie,” says Jim Gerhardt of Berks County, Pennsylvania. —Marc Silver

A giant pumpkin seed (right) is often bigger than the garden variety (above).



A tiny crack in the bottom of New Englander Steve Connolly’s 1,568-pound pumpkin cost it a prize last year.

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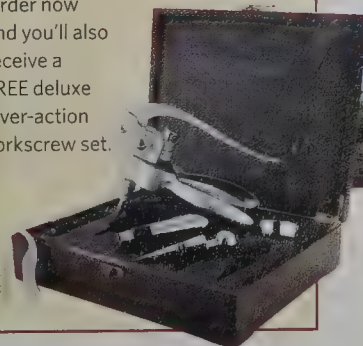
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Human Limits A 64-year-old Duluth woman fell on the ice last December. Arthritis kept her from getting up. She lay in the snow for hours. Her temperature dipped to 70°F. Her heart stopped. She should have been a goner. But doctors revived her; today she is fine. Medical science is always learning more about how much a body can take. Yet as Duke University physician Claude Piantadosi notes, "At some point it's impossible to rescue yourself." Here's current thinking on the extremes of human endurance. —Shelley Sperry

107.6°F



Body Heat

When core body temperature hits 107.6°F, heatstroke can't be reversed and will prove fatal.

40°F



Cold Water

Water saps body heat. You'd last barely 30 minutes in a 40°F sea. Life vests buoy you up to slow heat loss.

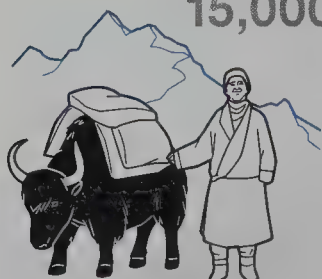
300°F



Hot Air

In a burning building or deep mine, adults can take 10 minutes at 300°F. Kids soon succumb in a 120° car.

15,000 feet



High Altitude

Consciousness fades for most. With bigger lungs and more red blood cells, highland dwellers are OK.

282 feet



Diving Deep

Without equipment, most folks black out before 2 minutes and below 60 feet. The best free diver made it to 282 feet.

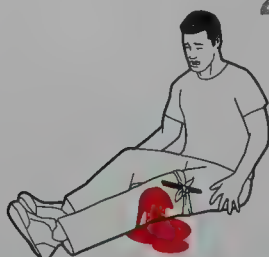
11 minutes



Lack of Oxygen

Typically, you'd pass out within 2 minutes. With training, people can hold their breath nearly 11 minutes.

40%



Blood Loss

You can survive after spilling 30 percent. At 40 percent, you'd need an immediate transfusion.

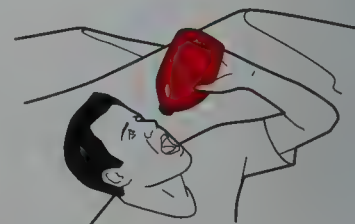
45 days



Starvation

Lose 30 percent of body weight and death is imminent, though disease will likely kill you before you starve.

7 days



Dehydration

Every cell needs water. Replace the quart or so you lose daily, or you won't last much more than a week.

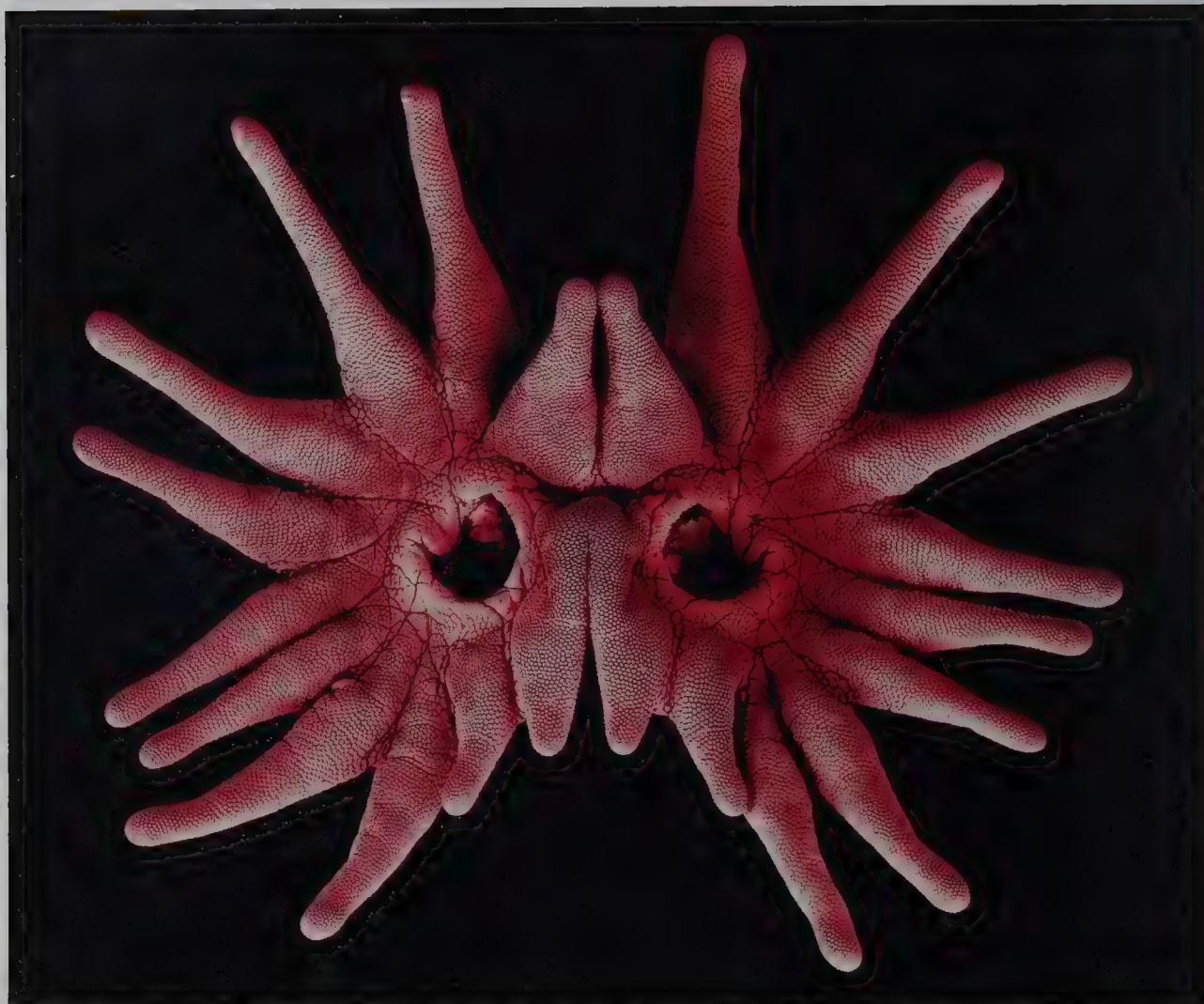
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The star-nosed mole's 22 sensory tentacles—less than an inch across—get an electron micrograph close-up.

The "star," with some 100,000 nerve endings, gives *Condylura cristata* its sensitive touch. Claws give it scraping power.

Fleet Eater What outlandish snoot is this? A handy one that helps the star-nosed mole clock in as the fastest forager among mammals. As the mole claws at wetland soil or stream sediment, the tentacles about its nose probe up to 13 spots a second for invertebrates, insect larvae, and other prey. Then in 230 milliseconds—quicker than our eyes can flit to a flash of light—the mole scrutinizes and devours the edibles. That's a record for pinpointing and eating food. (Bats are the likely runners-up.)

Five times more sensitive than human fingertips, the tentacles let this virtually blind animal perceive minute prey its competitors miss. "It's one of the most acute skin-sensory systems of any creature," says Vanderbilt University biologist Kenneth Catania, who studies the species. Equally effective underwater, those fleshy appendages feel for bottom dwellers as the mole inhales its exhaled bubbles to sniff out the meal—the latter a skill Catania recently discovered. "This mole," he says, "just keeps surprising us." —Jennifer S. Holland





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NEW YORK

A Grander K What is a kilogram? It's 2.2 pounds, of course. Or is it? The kilo is the only basic international standard pegged to a physical object—a 120-year-old platinum-iridium cylinder kept in a vault outside Paris and known as Le Grand K. In recent years scientists noticed slight variations in the cylinder's weight. They've gone into high gear to redefine the kilo as a universal constant based on nature instead of an object vulnerable to distortion.

Physicists in some countries are analyzing near-perfect spheres of pure silicon crystal that will allow them to count the number of atoms in a kilo for the first time. Other scientists are measuring the kilo in terms of gravity and magnetism. Once results are confirmed, an international committee will make the final decision on redefinition, perhaps as soon as 2011. "It'll be a grand thing," says physicist Richard Steiner, who leads the American effort. Then Le Grand K can gain or lose as much weight as it wants. —Hannah Bloch

STANDARD SOLUTIONS

Unlike the kilogram, the other six basic international units—meter, second, ampere, kelvin, mole, and candela—are defined by universal measures. The meter is defined by the length light travels in 3.3 nanoseconds.



German physicist Arnold Nicolaus wants to count the atoms in this silicon sphere to set a standard for the kilogram.

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Life on the Edge When it comes to hostile environments, few places can match Chile's Atacama Desert. It's one of the most arid places on the planet, moistened by just half an inch of rain a year. So no one thought the region's 20,000-foot-tall Socompa volcano could sustain much life. In fact, its oxygen-starved atmosphere and intense ultraviolet radiation suggest conditions on Mars.

Recently, though, microbial ecologist Steven Schmidt, a National Geographic grantee, and his team discovered the world's highest altitude bacteria near the volcano's summit. It's not clear how the microbes grow in such inhospitable terrain. But for scientists seeking life signs on Mars, they're cause for hope. Here on Earth, the bacteria may hold biotechnological promise, perhaps providing building blocks for sunscreen compounds. After all, Schmidt says, they "have an amazing ability to resist the sun." —Hannah Bloch



The desiccated remains of livestock litter the Atacama Desert, inhospitable to most life-forms.

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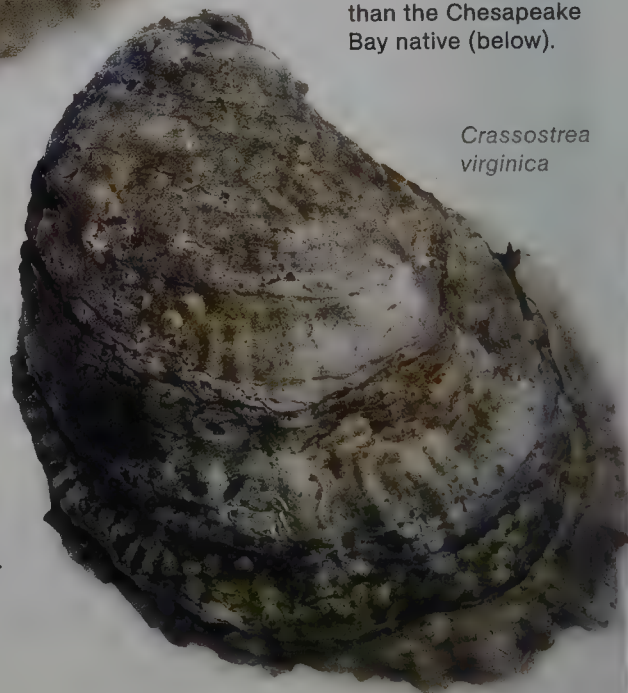
Crassostrea ariakensis

ACTUAL SIZE

The Suminoe oyster (above) grows faster than the Chesapeake Bay native (below).

Shell Shock Jamestown colonist George Percy wrote in 1607 that the oysters of the Chesapeake Bay lay “as thicke as stones.” In the 1970s the bay’s watermen hauled in about 25 million pounds of them a year. Now overharvesting, pollution, and disease have taken their toll, and the oysters are almost gone. The bay’s water is in terrible condition, in part because there are too few bivalves to filter it.

Introducing the hardy and fast-growing Asian Suminoe oyster was a possible solution. After much study, the U.S. Army Corps of Engineers and the states of Maryland and Virginia rejected the proposal this year, fearing the species could turn invasive and further disrupt the already imperiled ecosystem. The goal now is to protect the small population of native oysters and build them back over time. —Catherine L. Barker



Crassostrea virginica

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LEGAL NOTICE

**IN THE CIRCUIT COURT FOR THE THIRD JUDICIAL
CIRCUIT MADISON COUNTY, ILLINOIS**

CLASS ACTION SETTLEMENT **SUMMARY NOTICE**

TO: All Persons who, from October 26, 1989 through July 16, 2009, were injured in an automobile accident while drivers or passengers in an automobile insured by Allstate Insurance Company or a related entity ("ALLSTATE"), or submitted a claim to ALLSTATE under a homeowner's policy, and (a) who submitted claims under personal injury protection (PIP) or medical payments (MedPay) coverage for medical bills to ALLSTATE; (b) had those MedPay or PIP claims adjusted with the use of an ADP/MBRS computer recommendation; (c) received an amount less than the amount of the submitted medical expenses; and (d) received or were tendered an amount less than the full amount of the stated policy limits; as well as all medical providers and entities who, by written assignment, have the right to assert such claims. The Settlement Class shall exclude directors and officers of ALLSTATE and all members of the settlement class in Coffell v. Allstate, No. 05-2-33183-6 (Super. Ct. Wash. For King County).

Class action litigation against ALLSTATE has been pending in the Circuit Court of Madison County, Illinois. The Court preliminarily certified, for settlement purposes only, the Settlement Class above, and authorized publishing this Notice.

PLEASE TAKE NOTICE that the Court (Judge Ruth) will hold a hearing on November 25, 2009 at 10:30 a.m., at the Courthouse for the Circuit Court of Madison County, Illinois, Room 311, Edwardsville, Illinois 62025, to determine: whether the Court should finally approve the Proposed Settlement, bind the Class Members to the release set forth in the Proposed Settlement and enjoin Class Members from participating in or receiving benefits from any other lawsuit or other proceeding in any jurisdiction based on or relating to the Released Claims (as defined in the Settlement Notice and Stipulation of Settlement) in this case.

Class Description. The Court certified, for settlement purposes only, the class above. The Proposed Settlement covers ALLSTATE, and any of its parents, affiliates, stockholders, subsidiaries or divisions, or any other successors, assigns or legal representatives thereof.

A detailed Settlement Notice will be mailed to potential class members upon request. Potential class members should request a copy of that Notice by calling: 888-236-0299, or by accessing the following website: www.strasensettlement.com. The Proposed Settlement and the scheduled Court hearing may affect the Class Members' rights.

The Court appointed the following counsel as Lead Counsel for the Class:

Bradley M. Lakin
LAKIN CHAPMAN LLC

300 Evans Ave.

Wood River, IL 62095

Phone: (618) 254-1127

Email: Medpay.classaction@LakinChapman.com

**DO NOT TELEPHONE THE COURT OR THE
CLERK OF THE COURT.**

Dated: July 16, 2009, Edwardsville, Illinois.

/s/ Honorable Judge Ruth



How I Found The Gold Coin That Never Was

And how readers can take advantage of my major gold discovery!

by Nick Bruyer

Over a thousand years ago my Viking Warrior ancestors raided the coast of England in their great longships, striking terror into the hearts of their victims. But some of them stayed and settled on the Isle of Man, situated between England, Ireland and Scotland. It was during a visit to this ancient Isle that I stumbled onto something amazing—a precious piece of history that you can own and pass down through generations of your own family as a gold treasure of lasting value.

The Gold Coin That Never Was

As president of an international coin distributor, GovMint.com, I knew that the Isle of Man has its own legal tender coins. So I made a journey to the mint to meet the Mint Master. I was lamenting the fact that there was no gold coin commemorating their Viking heritage, when he told me that such a coin had been authorized, but never minted. The Twentieth Noble was to be struck in 99.99% fine gold. When I asked why it had never been minted, he didn't know. The Mint's official archives did not give a reason, but they revealed a startling fact.

I Seize a Golden Opportunity

The archives revealed the Government had given the Mint Master the authority to strike the Viking Gold Nobles *at any time*. When I asked if the Mint would strike them now, he agreed, but only if I would purchase the entire mintage. I could hardly believe my good fortune—it was like a dream come true.



Actual size
is 15 mm



The Viking Longboat Gold Noble—Available for the First Time

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Nicholas Bruyer is an award-winning professional numismatist and author with more than 30 years of coin market experience. Since 1985, tens of thousands of satisfied customers have acquired over \$400 million in coins from his companies. Note: GovMint.com is a private distributor of government and private coin and medallion issues and is not affiliated with the United States Government. Prices and availability subject to change without notice. ©GovMint.com, 2009

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MAPPING THE FOLDS

Unfolded, Robert Lang's paper stallion reveals its crease pattern—an origamist's blueprint (below). Each of the horse's appendages emerges from a circular region as the paper is flipped over and back along raised "mountains" (blue lines) and indented "valleys" (dashed red lines). Computer programs, including one by Lang, can plot such basic patterns. But the artist added many folds that aren't shown here to create the final shape.



"Alamo Stallion, Opus 384"

a centuries-old mathematical puzzle: how to pack spheres into a box or circles into a square. Mining the theory allowed origamists to plot complex designs with lots of limbs and also to find technological applications. When engineers working on the design of car air bags asked Lang to figure out the best way to fold one into a dashboard, he saw that his algorithm for paper insects would do the trick. "It was an unexpected solution," he says.

It was not, however, the first practical application of origami. In 1995 Japanese engineers launched a satellite with a solar array that folded in pleats like a map—an easy-opening kind invented by mathematician Koryo Miura—to fit into a rocket. Once in space, it opened flat to face the sun. Lang has since helped design a space telescope lens the size of a football field that collapses like an umbrella. Only a prototype exists

so far, but even that unfolds to nearly 17 feet.

Researchers are also working at the other size extreme, creating origami stents to prop open arteries and boxes made of self-folding DNA, billions of times smaller than a rice grain, to ferry drugs to diseased cells. Talk to one of these modern origamists and you'll see a new future unfolding. Someday, says MIT's Erik Demaine, "we'll build reconfigurable robots that can fold on their own from one thing into another," like Transformers. And someday, Lang thinks, all the myriad components of a building might be made from the same simple sheets, folded in myriad ways. "We haven't reached the limits of what origami can do," he says. "We can't even see those limits." —Jennifer S. Holland



For a demonstration of how to make a simple origami figure, go to ngm.com/bigidea.



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A tagged northern spotted owl swoops toward a researcher's lure in a young redwood forest.



A ragged blanket of coastal fog in northern California's Humboldt Redwoods State Park nurtures old giants alongside smaller second-growth trees outside the park. Redwoods depend on fog for more than 30 percent of their water needs.





Fourteen stories up a 30-story tree, Humboldt State University scientist Steve Sillett (at center) and his team measure a fire cave in a massive redwood in Prairie Creek Redwoods State Park. Wild fires have twice burned this tree but failed to kill it.





*A rare December snow dusts a trail through Del Norte Coast Redwoods State Park. Dependent on a cool marine climate, *Sequoia sempervirens*—the coast redwood—thrives between five and 30 miles inland.*



On a cutover California hillside thick with scrubby redwoods, Scotch broom, and poison oak, Mike Fay missed a step, started to slide, and felt a stiletto jab

the top of his left foot. After bushwhacking hundreds of miles in sandals, he was used to such insults to his 52-year-old feet. But this was the mother of all splinters. It bounced off a bone, lodged in a tendon, and refused to come out. Finally his hiking partner, Lindsey Holm, grabbed it with a pair of pliers and after several sharp tugs, yanked it free.

"You could hear me yelling from mountaintop to mountaintop," Fay says. "It was one of the most painful things I've ever experienced." Which is something coming from a man who was once gored 16 times by an elephant. He taped up the wound, shouldered his pack, and as he had for the past three months, kept walking.

After three decades of helping save African forests, Mike Fay, a Wildlife Conservation Society biologist and National Geographic Society explorer-in-residence, now has redwoods in his blood. His obsession with the iconic American trees began a few years ago after he completed the Megatransect—his Livingstone-like exploration of the largest intact jungle remaining in Africa. (See the October 2000, March 2001, and August 2001 issues.) One day while driving along the northern California coast, he found himself gazing at swaths of clear-cuts and spindly second-growth forests. Another time in a state park, a six-foot-tall slice of an old redwood log on display caught his attention. Near the burgundy center a label read: "1492 Columbus."

"The one that got me was about three inches from the edge," Fay says. "'Gold Rush, 1849.' And I realized that within the last few inches of that tree's life, we'd very nearly liquidated a 2,000-year-old forest."

In the fall of 2007 he resolved to see for himself how Earth's tallest forest had been exploited in the past and is being treated today. By walking the length of California's mythic range, from Big Sur to just beyond the Oregon border, he wanted to find out if there was a way to maximize both timber production and the many ecological and social benefits standing forests provide. If it could be done in the redwoods, he believed, it could be done anywhere on the planet where forests are being leveled for short-term gain. As he'd done on the Megatransect, he and Holm—a self-taught naturalist born and raised in the redwood country of northern California—took pictures and detailed notes on their 11-month trek, exhaustively recording wildlife, plant life, and the condition of the forest and streams. They talked to the people of the redwoods as well: loggers, foresters, biologists, environmentalists, café owners, and timber company executives—all dependent on the forest.

It was an auspicious year to be walking the redwoods. After more than two decades battling environmentalists and state and federal regulators over its aggressive cutting practices, the oft vilified Pacific Lumber Company was bankrupt and up for grabs. Even with most of the remaining old growth protected, the emblematic species

of the great forests—northern spotted owls, elusive little seabirds called marbled murrelets, and coho salmon—continued their dangerous decline, while the reeling economy and housing bust were shuttering sawmills throughout the redwood range. Fires scorched hundreds of thousands of acres in the worst fire season in memory. Tourism was down.

But something else was taking root among the trees Woody Guthrie lionized in “This Land Is Your Land.” The buzz among environmental groups, consulting foresters, and even a few timber companies and communities was that the redwoods were at a historic crossroads—a time when society could move beyond the log/don’t log debates of decades past and embrace a different kind of forestry that could benefit people, wildlife, and perhaps even the planet. The more Fay walked, the more convinced he became.

“California revolutionized the world with the silicon chip,” Fay says, his voice deceptively soft. “They could do the same with forest management.”

FAY AND HOLM started their walk at the southern end of the forest, where the trees grow in scattered holdings and groves in the Santa Lucia Range and the Santa Cruz Mountains. Except in small parks like Muir Woods outside San Francisco and Big Basin near Santa Cruz, where they encountered a few rare patches of ancient trees, they zigzagged 1,800 miles through stands that had been cut at least once and many that had been cut three times since 1850, leaving islands of larger second-growth forest in a sea of mostly small trees.

But on a glorious May day, nearly three-quarters of the way into the transect, they arrived at the southern end of Humboldt Redwoods State Park, home to the largest contiguous block of old-growth redwood forest left on the planet—some 10,000 acres. The alluvial flats along its creeks and rivers are prime redwood habitat, where the mix of rich soils, water, and fog rolling in from the ocean have produced the planet’s tallest forest. Of the 180 known redwoods greater than 350 feet, more than 130 grow right here.

Fording a vein of emerald water known as the South Fork of the Eel, they climbed the far bank and entered the translucent shade of the most magnificent grove they’d seen yet. Redwoods the size of Saturn rockets sprouted from the ground like giant beanstalks, their butts blackened by fire. Some bore thick, ropy bark that spiraled skyward in candy-cane swirls. Others had huge cavities known as goose pens—after the use early pioneers put them to—big enough to hold 20 people. Treetops the size of VW buses lay half-buried among the sorrel and sword ferns, where they’d plummeted from 30 stories up—the casualties of titanic wars with the wind, which even now coursed through the tops with panpipe-like creaks and groans. It’s no wonder Steven Spielberg and George Lucas filmed scenes for the *Jurassic Park* sequel and *Return of the Jedi* among the redwood giants: It felt as if a *T. rex* or a furry Ewok could poke its head out at any minute.

Redwoods are no less magical for foresters. Because their bark and heartwood are rich in compounds called polyphenols, bugs and decay-causing fungi don’t like them. And since there’s not a lot of resin in their stringy bark, larger redwoods are highly resistant to fire.

Perhaps the most amazing thing about redwoods is their ability to produce sprouts whenever the cambium—the living tissue just beneath the bark—is exposed to light. If the top breaks off or a limb gets sheared or the tree gets cut by a logger, a new branch will sprout from the wound and grow like crazy. Throughout the forest you can find tremendous stumps with a cluster of second-generation trees, often called fairy rings, around their bases. These trees are all clones of the parent, and their DNA could be thousands of years old. Redwood cones, oddly enough, are tiny—the size of an olive—and may produce seeds only sporadically. As a result, stump sprouting has been key to the survival of the redwoods throughout the logging era.

The trees have another trick foresters love.

Contributing Writer Joel Bourne reported on the global food situation in June. Photographer Michael Nichols is an editor at large for the magazine.

With their high tolerance for shade and ability to sprout, some redwoods can sit almost dormant in the shade of their elders for decades. Yet as soon as a dominant tree falls or is cut down, breaking the canopy and allowing new light to enter the forest, the suppressed redwood springs up with new growth—a phenomenon known as release.

“Redwoods are what’s known in biology as a very plastic species,” says Evan Smith, vice president of forestland for the Conservation Fund. “It’s like a machine. Once you get it going, you can’t stop it.”

IT COULD BE SAID that the history—and split personality—of modern America is carved in redwood, with the calls to save the trees reverberating almost as soon as we began cutting them down. For millennia the Tolowa, Yurok, and Chilula tribes, among others, lived behind an almost impenetrable redwood wall more than 300 feet high, eating salmon, elk, and tan oak acorns and carving long canoes from the logs that fell to the ground.

That way of life ended violently in 1848 when the U.S. wrested California away from Mexico and gold was discovered there. Businessmen from the East thought they saw an easier source of riches: the reddish, straight-grained, rot-resistant wood already in high demand in a state that would quadruple its population in a decade. In time the great forests near San Francisco were virtually leveled. Farther north, timber barons used fair means and foul to acquire thousands of acres of federal lands in the redwoods for \$2.50 an acre, beginning an era of corporate lumbering that continues to this day. (Of the 1.6 million acres of redwood forest, 34 percent is owned by three companies, 21 percent by the state of California and the federal government, and the rest by smallholders.) By the 1880s some 400 sawmills north of San Francisco were churning out a mother lode of “sequoia gold,” which for nearly the next century would become an inextricable part of every Californian’s life—from the redwood cradles they were rocked in to the redwood coffins they were laid to rest in.

The 1906 San Francisco earthquake and fires kicked the cutting into overdrive. To meet demand for timber to rebuild the city, logging towns sprang up throughout the redwood range, and companies such as Pacific Lumber and Union Lumber flexed newfound industrial muscles. In place of teams of oxen, portable engines called steam donkeys dragged the massive logs, and narrow-gauge locomotives hauled them from the woods. Grainy photos from the “golden age” of logging show grinning timbermen with mustaches and suspenders standing atop felled trunks the size of Boeing 747s.

The felling of the great trees also helped spark the modern conservation movement. In 1900 concerned citizens formed the Sempervirens Club, whose advocacy led to the creation of Big Basin Redwoods State Park in 1902. In the 1920s the Save the Redwoods League began purchasing the groves that would become the backbone of California’s redwoods parks, and it continues adding them to this day.

The last, and most intensive, burst of logging began after World War II, when the housing boom and a glut of cheap military-surplus equipment unleashed an army of bulldozers, log trucks, and chain-saw-wielding loggers onto the steep, unstable soils of the redwood forests. By the early 1950s mills were sawing more than a billion board feet of lumber a year, a level maintained until the mid-1970s. (A board foot is the equivalent of a slab of wood one foot square and one inch thick.) Clear-cutting and Cat logging, named after the yellow Caterpillar tractors that became the workhorses of the timber industry, unleashed a torrent of soil into streams from a latticework of logging roads and skid trails. Salmon runs dwindled, and so did other species that had existed in the redwoods for millennia. Today less than 5 percent of the roughly two million acres of virgin forest remains, mostly in parks and reserves throughout the range.

“The battle to save the redwoods has already been fought, and look, we’re left with table scraps,” says Steve Sillett, a forest scientist at Humboldt State University. “The challenge now is understanding how to improve management

on the 95 percent of the redwood landscape that's just starting to grow.”

SALMON AND SPOTTED OWLS aren't the only things to have suffered with the felling of the forest. Harvest rates in the redwoods have plummeted since the 1990s, when they were already half what they were in the 1970s. Though Fay and Holm spent nearly every night under the stars, every two weeks they'd hit little logging towns to recharge computer and camera batteries and download their data on portable hard drives—places like Korbel and Orick that once boasted several sawmills but are now lucky to have one still limping along. Rio Dell, a town of 3,200, has been luckier than most. It sits across the Eel River from Scotia, home to what was once a venerable timber enterprise: Pacific Lumber Company.

Last year more than the typical thick, gray clouds were hovering over Rio Dell's Wildwood Days, the annual street festival replete with logging contests, bocce tournaments, and bucket brigade races between local volunteer fire departments. Days earlier, after a protracted fight in federal bankruptcy court, PL (as the company is known here), employer of generations of the two towns' mill workers and woodsmen, had been sold. The future was now in the hands of Mendocino Redwood Company (MRC), owned by the Fisher family of San Francisco, who had made their fortune with the Gap and Banana Republic clothing chains. The only thing most people in Rio Dell knew was MRC's new incarnation of the old Pacific Lumber operation: Humboldt Redwood Company (HRC). No one knew who would have jobs when the dust cleared.

Down at the logging contest—featuring an event in which two men see who can cut a log faster with chain saws—Len Nielson of Fortuna just beat out Chris Hall of Rio Dell, a big man with a shaved head, a neat, red goatee, and a tattoo that read “HOSS” across his Popeye-like forearm. All told—grandfather, dad, uncles, and cousins—Hall's family had spent 142 years working for PL. He'd been felling trees, driving

Redwoods the size of Saturn rockets sprouted from the ground like giant bean- stalks, their butts blackened by fire.

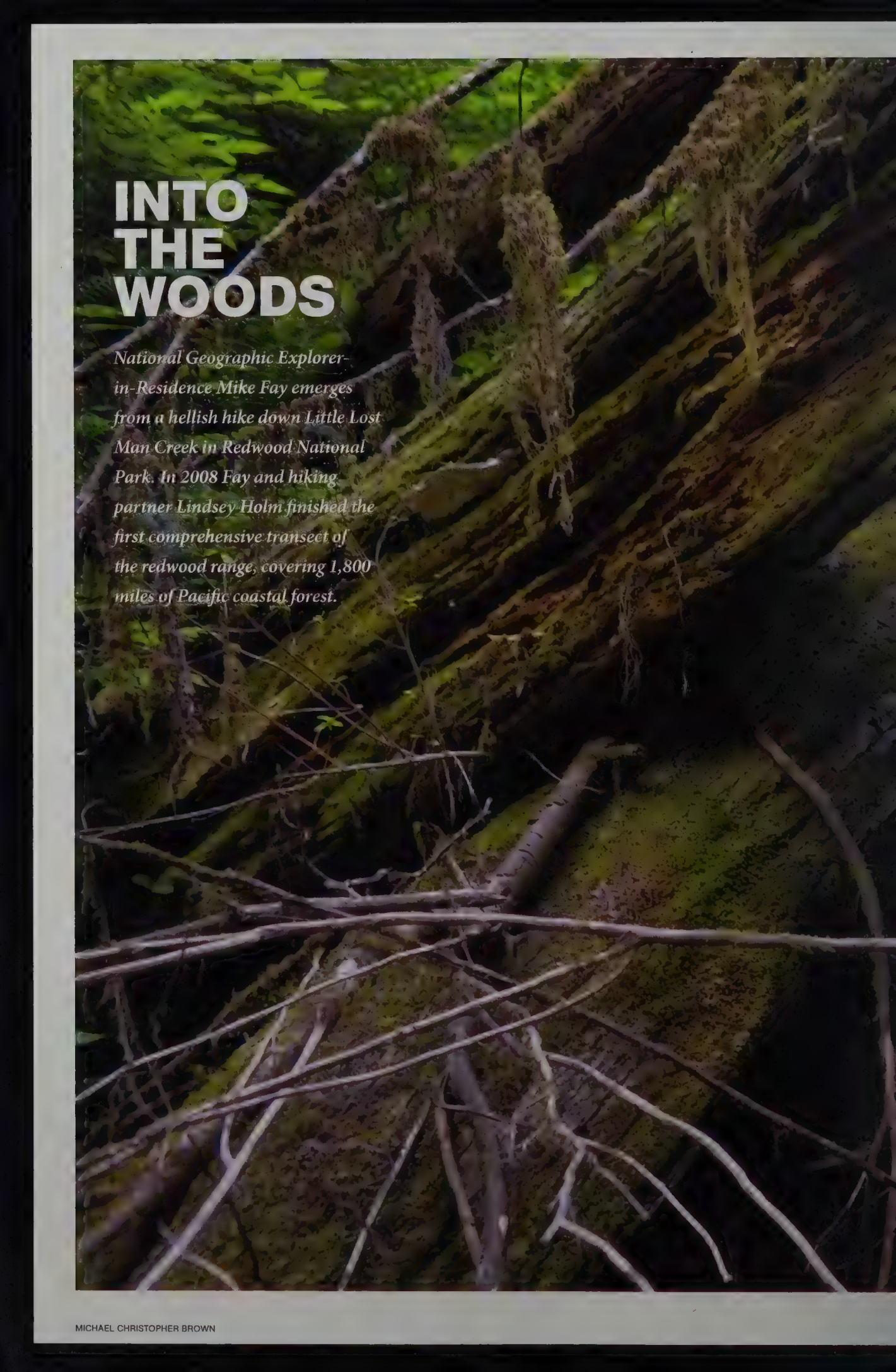
Cats, skidding logs since he was 15. Now he works in the power plant.

“We're definitely glad to see Hurwitz go,” Hall says, as he puts away his chain saw, with his five-year-old daughter dancing at his feet.

It's hard to have a conversation about forestry practices in the redwoods without hearing the name of Charles Hurwitz, CEO of Houston-based Maxxam, Inc. In 1985 Hurwitz orchestrated the hostile takeover—underwritten by junk bonds provided by the financier Michael Milken—of Pacific Lumber, which had been run conservatively by the Murphy family since 1905. By leaving some of their old growth standing, the Murphys, men who learned the lumber business from the chain saw up, had planned to sustain their timber harvest and jobs well into the 21st century. “When the Murphys owned PL, they cared for their employees,” Hall says.

With Pacific Lumber, Hurwitz inherited roughly 70 percent of the remaining old redwoods in private hands. In his first meeting with the employees, the dark-suited businessman told them—in a now famous quote—that he believed in the golden rule: “He who has the gold, rules.” Hurwitz then proceeded to break up the company and sell its assets. He sold Pacific Lumber's office building in downtown San Francisco and a profitable welding division, and he cashed out the workers' pension fund, replacing it with an annuity from a poorly rated insurance carrier.

Most important for the redwoods, Hurwitz adopted a business model of clear-cutting, doubling—and some years even tripling—the annual amount of timber harvested from



INTO THE WOODS

National Geographic Explorer-in-Residence Mike Fay emerges from a hellish hike down Little Lost Man Creek in Redwood National Park. In 2008 Fay and hiking partner Lindsey Holm finished the first comprehensive transect of the redwood range, covering 1,800 miles of Pacific coastal forest.



From the southernmost redwood in Big Sur to the northernmost tree near Oregon's Chetco River, Mike Fay and Lindsey Holm spent almost a year walking the redwoods (map, far right), stopping often to record plants, animals, and forest conditions around them. They passed through the birthplace of redwood logging in the Santa Cruz Mountains (top left), through San Francisco, rebuilt with redwood timber after the earthquake and fires of 1906, and across the Golden Gate Bridge (top right). Hauling laptops, hard drives, and cameras in 60-pound packs, they used the woods as their office and springs and rivers as their faucet and bathtub (middle left). Their focus was forest management, whether noting the size of a truck-load of logs (middle right), checking out a burn pile in a clear-cut (bottom left), or looking for marbled murrelets up high in old growth (bottom right). "In 20 years we won't think of logging these lands like we do today," Fay says. "Our knowledge of these forests is constantly evolving."



Society Grant The Redwood Transect was funded in part by your National Geographic Society membership. Additional support came from Wildlife Conservation Society and Save the Redwoods League.



the company's holdings, which eventually reached 210,000 acres. His attempts to cut the largest remaining block of old growth on private land, known as the Headwaters Forest, launched an army of young protesters into the streets and up the trees and drew increased scrutiny from state timber regulators and federal wildlife agencies. For forest defenders, as the protesters call themselves, it was a dangerous time. Tree sitters were extracted by force from their platforms hundreds of feet in the air. The late Judi Bari, one of the organizers of a series of protests in 1990, a time known as "redwood summer," had her pelvis shattered by a pipe bomb placed in her car. No one was ever charged in the crime.

In 1998 David "Gypsy" Chain and some other protesters hiked out to a PL tract where they believed loggers were building roads before the end of the marbled murrelet nesting season, when logging is illegal. One logger, caught on videotape, cursed them, saying he wished he'd brought his gun. Then he felled a redwood in their direction. The tree struck Chain in the head, killing him instantly. The logger was never charged. In 1999 the state and federal governments purchased part of the Headwaters Forest, putting it under permanent protection.

THE DAYS OF violent confrontations seem to be over now. A week after MRC's acquisition of Pacific Lumber, Mike Jani, the company's president and chief forester, asked Fay and Holm to join him and local activists at the foot of a redwood giant just across the Eel River from Rio Dell. Protesters had occupied part of an old-growth grove here for years to keep PL from logging. Jani told the activists that under the new company's policies the trees would not be taken, and "Do Not Cut" flagging was put up around the survivors.

"Fighting for old growth is easy," Lindsey Holm told me. "It's a moral issue, black-and-white. Save the old trees—the endangered species. It's a no-brainer." Trying to rally people around sound second-growth forestry is more challenging—more about keeping the ecosystem intact by minimizing erosion and maintaining

wildlife while maximizing timber production. For most Californians, clear-cuts are bad forestry because they're ugly. That misses the point, said Holm, who isn't necessarily averse to clear-cuts. "This is about good forestry, not about what you can see out your kitchen window."

The notion that you can log a forest without leveling it isn't new. As early as the 1930s Emanuel Fritz, a forestry professor at the University of California, Berkeley, argued that if timber companies wanted to be in business in 40 to 50 years—the time he estimated it would take to cut all the remaining old-growth forest—they'd better start leaving some trees for the future. In line with this thinking, Albert Stanwood Murphy decreed that Pacific Lumber would never cut more than 70 percent of a stand of timber or cut more from its forests than would grow in a year—policies the company held for more than half a century until Charles Hurwitz tossed them out.

Now Jani promises that the new Humboldt Redwood Company will bring selective cutting back to the old Pacific Lumber lands. Its parent company, MRC, has already implemented the approach on 230,000 acres of heavily logged redwood forest in Mendocino County it purchased from Louisiana Pacific a decade ago. MRC stabilized logging roads, reestablished stands, and made a practice of cutting a third to a half of the overall volume of timber grown on its property each year through a variety of selection techniques. By doing this, the company has sacrificed greater short-term profits for long-term investment in the forest.

Scott Greacen, executive director of a local group called the Environmental Protection Information Center (EPIC), is watching closely to see how HRC manages its new holdings. However, when Fay and Holm visited Greacen at the EPIC office in downtown Arcata, the maps of PL timber-harvest plans had been replaced by those of another large industrial landowner: Green Diamond Resource Company.

Green Diamond is now the largest clear-cutter in the redwoods, with more than 70 percent of its 430,000 acres given over to uniform stands that

Clear-cutting and Caterpillar logging unleashed a torrent of soil into streams. Salmon runs dwindled, and so did other species.

are logged roughly every 50 years. When asked if the company was EPIC's next target, Greacen says, "I think we're going to have something to say about short-term, even-age forestry."

"HERE WE LOVE even-age forests," says Greg Templeton, one of Green Diamond's veteran foresters. "Both redwoods and Doug fir grow faster in full sunlight." He was standing on a hot, sunny hillside, watching with pride as a logging crew reduced a 70-year-old stand of 150- to 200-foot redwoods into an organized tangle of slash, limbs, and logs.

In the 1990s California reduced the maximum allowable size for a clear-cut from 80 acres to between 20 and 40. The heavy tractors that caused so much erosion have largely been replaced by smaller, lighter shovel loaders—tracked machines that look like old-fashioned steam shovels with an articulated grapple on the end. By picking up entire logs instead of dragging them on the ground, shovel loaders eliminate the erodible skid trails that were the hallmark of Cat logging and the bane of salmon-spawning creeks. For target trees on steep hillsides, foresters use a cable yarder, a setup that hoists cut logs along a cable running from a tall tower placed at the top of the hill to a massive stump on the opposite slope. According to Templeton, the switch to such machinery, along with fewer, better-built logging roads and mandated buffer zones along streams (where some selective cutting is allowed), significantly reduces sediment going into salmon-spawning waters.

Green Diamond's puzzle-piece forests, with blocks of tightly packed small trees up to 20 years old separated by slivers of older trees in the 150-foot buffer zones around fish-bearing streams, will ultimately provide good wildlife habitat, says Neal Ewald, the company's vice president and general manager. "Fifty years from now 20 percent of this landscape will stick up like veins on a maple leaf, with a network of old trees around the streams," he explains. "We're on target to create the same kind of trees you see in Redwood National Park in a hundred years," to the benefit, he says, of salmon and northern spotted owls.

In the early 1990s Green Diamond's senior biologist, Lowell Diller, was among the first to find high densities of spotted owls in second-growth forests. His research indicated that the owls can survive in the smaller forests as long as they have enough old snags and large trees with cavities and platforms for nesting. And the mix of young forest blocks of various ages created by clear-cuts provides good habitat for dusky-footed wood rats—the owls' favorite prey in California.

Diller's findings helped Green Diamond secure the first Habitat Conservation Plan (HCP) for spotted owls from the U.S. Fish and Wildlife Service in 1992, which allowed the company to continue logging in spotted owl territory as long as they had a plan to maintain a minimum amount of owl habitat. Yet owls have been declining by about 3 percent a year on Green Diamond lands since 2001, Diller says, as they have over much of their range.

Part of the problem is a mysterious drop in the wood rat population, as well as increased competition from the more aggressive and adaptable barred owl, which has muscled into the spotted owls' territory from the east.

Young forests have shown other unintended wildlife consequences. In spring, before berries and acorns come in, black bears depend in part on the sap just under the bark of redwoods and other conifers. They prefer the young, fastest growing trees and have done so much damage to commercial stands that some foresters call them the biggest "pest" in the redwoods. But bears became a problem only when companies began growing trees like a crop.



Ray "Old Growth" Wood makes the undercut on a redwood 30 inches in diameter—a sapling compared to the 16-footers he cut as a young man. "It's boom and bust," 67-year-old Wood says of the log market, now at its lowest point in decades.





AFTER WALKING through every kind of managed forest and talking to foresters on all sides of the issue, Mike Fay is convinced there's a better way: Grow bigger trees, which can maximize wood production while providing good habitat. "You've got to start thinking about this as an ecosystem," he says. "All these plantations might as well be growing corn. But if you want clean water, salmon, wildlife, and high-quality lumber, you've got to have a forest."

Fay is not alone. "My idea is to cut less trees and make more money per tree," says Jim Able, a former industrial forester for Louisiana Pacific who now manages small private timberlands, most fewer than a thousand acres. Wearing his trademark straw hat, Able leads Fay through the Howe Creek tract, a timber plot he's managed for nearly three decades and is thinning for

the third time. Douglas firs and large second-generation redwoods, three or more feet thick and up to 200 feet tall, rise from the steep hillside straight as arrows. Here and there a few trees lie on the ground, waiting to be yarded, creating a mosaic of shadow and sun. The key, Able says, is form. He and his foresters mark every tree they want cut, aiming never to exceed 30 to 35 percent of the volume of the stand. Unlike high-grading, a form of selective logging that Able considers worse than clear-cutting because it takes the best and leaves the rest, Able cuts weak and poorly formed trees, leaving the straightest and strongest to thrive in the newly available light. And unlike timbermen who harvest clear-cuts every few decades, Able comes back once a decade to evaluate whether to cut again. He never takes more



Redwoods produce more wood, and better wood, as they age. Sillett thinks this may be true for other trees around the world.

Laughter cheers the struggling Humboldt County lumber town of Rio Dell as kids get splashed during the annual Wildwood Days fair. Local unemployment hit a 16-year high this March. With timber demand down, Humboldt Redwood Company will cut just a third of its planned 2009-2010 harvest.

which can be used to offset emissions. Thanks to their phenomenal growth, resistance to disease, insects, and rot, and their incredibly long lives, redwood forests are the best of all forests at capturing carbon dioxide from the atmosphere and locking away the carbon in their wood. California's voluntary market for forest landowners is among the most rigorous in the world. The market allows owners to sell credits for the carbon stored in each year's grown wood as long as they guarantee to maintain that growth for a century.

Money for carbon stored in living trees could help landowners make the transition from short-term clear-cuts to long-term rotations where bigger, higher quality trees could once again dominate the landscape. So far, based on the amount of carbon the van Eck is estimated to sequester over a hundred years, the Pacific Forest Trust has sold more than two million dollars' worth of emissions-reduction credits.

Another group practicing ecological forestry, Evan Smith's Conservation Fund, bought 40,000 acres of industrial timberlands in the Garcia River, Big River, and Salmon Creek watersheds to keep the trees from becoming vineyards and subdivisions. The organization plans to use uneven-age selection forestry to restore aquatic habitat by reducing erosion into the streams. To help with financing, it is selling millions of dollars' worth of carbon-reduction credits to Pacific Gas and Electric Company as well as to several investment firms.

California's Air Resources Board now plans to adopt an updated carbon protocol for forestry, hoping to attract (Continued on page 58)

wood than the forest has grown over that time, which means that the remaining trees—what he calls his principal—continue to increase in height, volume, and quality.

"What I'm doing is growing old trees and taking the interest in the interim," he says. "I firmly believe I can keep doing this over a hundred years."

More landowners are following in Able's footsteps, growing their redwoods older and cutting them more sparingly. Some call this ecological forestry, in which the forest is managed to provide wildlife habitat and clean rivers as well as forestry jobs and wood products. The 2,200-acre van Eck Forest near Arcata, managed by the Pacific Forest Trust, serves an additional purpose: It earns some of its keep by providing greenhouse gas reductions,



Roosevelt elk cows scatter across a meadow in Prairie Creek Redwoods State Park as two bulls vie for dominance of the herd. Largest of North America's elk subspecies, their name honors conservationist President Theodore Roosevelt.





A black bear saunters past a camera trap set by photographer Michael Nichols. When more nutritious foods are scarce, bears often strip the bark off young redwoods to get at the sap below, wreaking havoc on regrowth in timberlands.



FORESTS IN THE AIR

Hundreds of feet above the ground, the crowns of ancient redwoods shelter another forest. Thickets of berry bushes, ferns, and other conifers—some large enough to bear cones—rise from dense mats of soil on broad limbs or in trunk forks. The soil, as thick as three feet, forms from decayed leatherleaf ferns and redwood leaves and bark, nourishing an aerial ecosystem unknown until the 1990s, when scientists first climbed into the canopy.

MARBLED MURRELET

The endangered web-footed seabird nests in the crowns of large conifers in old-growth forests, flying as far as 50 miles between nest and Pacific to feed.

STELLER'S
JAY

REDWOOD
TRUNK
GROWING
FROM LIMB

LEATHERLEAF
FERN

EVERGREEN
HUCKLEBERRY

SALAMANDER

SEAN MCNAUGHTON, NG STAFF; DITA SMITH
ART BY AMADEO BACHAR

SOURCES: STEVE SILLETT, HUMBOLDT STATE
UNIVERSITY; GEORGE KOCH, NORTHERN
ARIZONA UNIVERSITY

AREA
ABOVE

HOW THE TALLEST TREES DRINK

As water evaporates from leaves, more water is pulled up in a continuous chain. Special aspects of redwood cells may help water keep rising against gravity to extreme heights. Leaves also absorb water directly from rain and fog.

CANOPY PREDATOR

Climbing from the forest floor, the wandering salamander may stay in the canopy, hunting insects and other invertebrates. Lacking lungs, its body must remain moist to allow it to breathe through its skin.



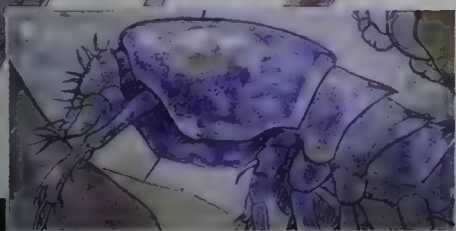


B. COPEPODS

C. FUNGI

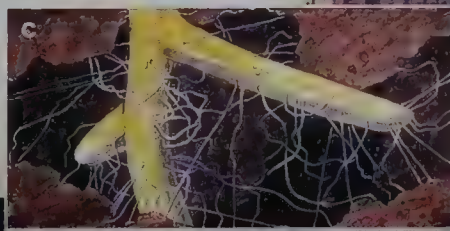
CANOPY SOIL

Soil mats can store enough water to sustain a canopy community during the dry summer. The tree itself may benefit by drawing water and nutrients through roots sent out by its additional trunks that rise from limbs.



UNEXPECTED RESIDENTS

Barely visible, aquatic crustaceans called copepods live in soil mats far above their usual home in streams. Needing only a thin film of water to move, they likely swim up redwood trunks during storms.



PARTNERSHIP

Fungi colonize the roots of woody plants in a symbiotic relationship, helping plants absorb nutrients and water. Fungi also speed decay of dead vegetation to produce canopy soil.





Partway up a 350-foot tree, botanist Marie Antoine (at right) passes a slender core sample of its wood—750 years of redwood biography—to canopy ecologist Giacomo Renzullo. Research now shows that the older such trees get, the more wood they put on.

“California revolutionized the world with the silicon chip. They could do the same with forest management,” Mike Fay says.

(Continued from page 49) the industrial timber owners. “If we can get the carbon incentives right, we can double or even triple our inventory in the redwoods,” Mike Fay says.

ON A DAY WHEN the early morning sun is filling the mist-shrouded canopy of Prairie Creek Redwoods State Park with an iridescent glow, Mike Fay hooks his ascender to a climbing rope and “jugs” up a truly massive redwood to talk to one scientist who is convinced of the value of letting redwoods grow big. Steve Sillett has made a name for himself by finding, climbing, and studying the tallest trees on the planet. He has meticulously measured hundreds, from their mighty bases right up to the individual needles at the top. At 138 feet up, Fay passes a fire cave big enough for two grown men to stand in amid a thicket of reiterated trunks and branches—battle scars from centuries of skirmishing with fire and wind. Higher still, epiphytic ferns and huckleberry bushes grow in deep canopy soils, while a myriad of mosses, liverworts, and lichens cover the bark. This tree, at 301 feet, isn’t even close to the world’s tallest, at 379.1, but according to Sillett, who is waiting for Fay at an opening in the canopy right at the very top, it is “super juicy”—loaded with canopy soils and biodiversity. From there the two men peer out upon a nearly unbroken expanse of huge redwoods, with one clear-cut barely visible to the south.

The mantra of industrial foresters has long been to grow trees as fast as possible to maximize the return on investment and provide a steady flow of wood products to market. For them, the

Laying hands on an old friend, activist Amy Arcuri shows her delight in Spooner, a giant she says is nearly 2,000 years old. Once slated to be cut, the tree has been declared off-limits by its new owner, Humboldt Redwood Company. “I try to believe there can be progressive change,” Arcuri says.



most profitable time to cut redwoods is at 40 to 50 years, even though such young trees contain mostly soft, low-quality sapwood, with little of the redwoods’ legendary resistance to rot. But after coring and measuring two dozen trees—95 feet to 370 feet tall—from canopy to base in Humboldt Redwoods State Park, Sillett discovered that a tree’s annual rate of wood production increases with age for at least 1,500 years. More important, the older it gets, the more high-quality, rot-resistant heartwood it puts on. The bottom line: Redwoods produce more wood, and better wood, as they age. Sillett says this is true for the tallest eucalyptus trees in Australia too, and he thinks it may be true for other trees around the world.

“If it’s all about short-term yield, there’s not an effective argument for big trees,” Sillett says.



“But if it’s about long-term yield, carbon sequestration, and ecosystem services, then you’ve got an effective argument for old trees. What do we need to remove and keep lots of carbon out of the atmosphere? Massive amounts of decay-resistant wood.”

ON THE LAST DAY of their transect, as they hunted for the northernmost redwood near Oregon’s Chetco River, Mike Fay and Lindsey Holm talked about the characters they’d met in the forest. There were Lud and Bud McCrary, octogenarian brothers who pioneered uneven-age forestry in the Santa Cruz Mountains—Lud’s family even built a redwood bomb shelter after the Cuban Missile Crisis in 1962. And there was the story of Tim Renner, a veteran logger with a hearty dislike for forest activists. Renner told about the

time he had been hired to cut some trees in the Arcata Community Forest, a selectively logged tract near town that also serves as a community park. He was putting away his chain saw at the end of a day’s work when a young man came walking down the trail with long hair, a long beard, and dirty clothes. And Renner thought, This kid is going to chew me up.

The young man stopped and looked at the freshly cut forest, and to the logger’s astonishment, he said, “This looks great! There’s so much more light coming in. I really like the way this looks.”

Which means that along with high-quality wood, carbon storage, clean water, and wildlife habitat, ecological forestry can bring back another benefit for which redwoods are justly famous: utter awe. □

THE REDWOODS POINT THE WAY

*A conservationist sees a new wave
of enlightened forestry as a model for
wiser stewardship of nature.*

ESSAY BY J. MICHAEL FAY

ON DAY 323 of the transect, in Jedediah Smith Redwoods State Park, I dropped over a log 18 feet in diameter into an abyss of giant botanical pickup sticks, deadfall that had piled up amid the living trees over thousands of years. Another fallen monster loomed. Grabbing huckleberry roots and clumps of sword ferns, I hauled myself and my 60-pound pack up its organic wall onto a trunk as long as a football field. Filthy and exhausted, surrounded by hundreds of towering redwood columns that were raining their captured fog on my head, I stood there overwhelmed by a scene straight out of the Jurassic.

I've been walking in forests for 40 years; never could I have imagined a woods as grand as this.

Staring skyward through the somber silhouettes, I thought about the timberman who had described his company's patchwork of clear-cuts, with their sun-drenched mix of tiny trees interspersed with strips of older redwoods, as functionally the same as an old-growth forest. No amount of persuasive conversation or data will ever convince me of that. This isn't about loving big trees. It's about the fact that I spent 333 days

walking 1,800 miles through the entire range of the redwoods with a notebook in my hand, documenting details about this ecosystem—and witnessing the aftermath of the cutting of at least 95 percent of the most wood-laden forest on Earth.

Timber folks know the history—most I met in redwood country used words like nuked, hammered, blitzed, wasted, and raped to describe the logging of the past. The landscape bears them out. I spent too many days on the transect pushing past gigantic stumps, through weedy stands of small trees amid crumbling road systems, over eroded hillsides, and across rivers choked with gravel and silt, whose fisheries had collapsed. It was a landscape shaped by greed and waste.

The time to argue about the wisdom of liquidating the resource base of the planet is over.

In the redwoods I found many who agree. Dave Lewers, whom I joined on the 12,000-acre Flat Ridge Ranch he meticulously manages in Sonoma County, said it best: "They might think I'm a gun-toting, right-wing redneck, but what they have to understand is, they've got our attention." The "they" are environmentalists and state regulators, and what Lewers meant was that he is a frontline participant in efforts to restore the redwood forest.

All along the transect I met foresters, owners,

J. Michael Fay is a conservationist and senior explorer at the Wildlife Conservation Society and a National Geographic Society explorer-in-residence.



GLASS PLATE: ERICSON COLLECTION, HUMBOLDT STATE UNIVERSITY LIBRARY
THIS PHOTOGRAPH IS REPRODUCED AS A NEGATIVE TO SHOW THE GLASS IMAGE AS A POSITIVE.

A glass-plate negative from the 1890s, held by Edie Butler of Humboldt State University, records one of countless fallen giants. Only a fraction of the original redwood forest remains.

and loggers who talk as if they've discovered the holy grail of redwood management. People like Jim Able, Jim Greig, and Ed Tunheim who have found a way to bring vigor back to this ecosystem—and stay in business at the same time. What they're learning, and how they're applying that knowledge, can serve as a blueprint for the entire redwood range. Their ability to supply large amounts of lumber for humanity and improve ecosystem function is an approach that should be adopted around the world.

In brief: These veteran foresters are carrying out a form of single-tree selection that is more

productive in the long term than clear-cutting. Every 10 to 15 years they take about a third of the timber in a stand, going for the least robust trees—the runts, as Jim Able calls them. This creates more open space, allowing the remaining trees to get a greater share of the sunlight, which speeds their growth. Every year the amount and quality of the standing wood increase, and because regeneration happens gradually, the process can proceed for centuries. The advantages are twofold: short-term income and a larger payback over the long term. "You can't be greedy or in a rush," Ed Tunheim says.

This isn't just about wood. Past damage to ecosystems is being repaired. Sediment is being excavated from streams to restore their original beds, and culverts enlarged to permit natural stream flow. Thousands of logs are being placed



in creeks to create fish habitat. Roads are being recontoured and reinforced or simply erased from the landscape. Along rivers and in slide-prone areas, timber harvests are being reduced. Trees identified as crucial for wildlife habitat—and remnant old growth—are being preserved.

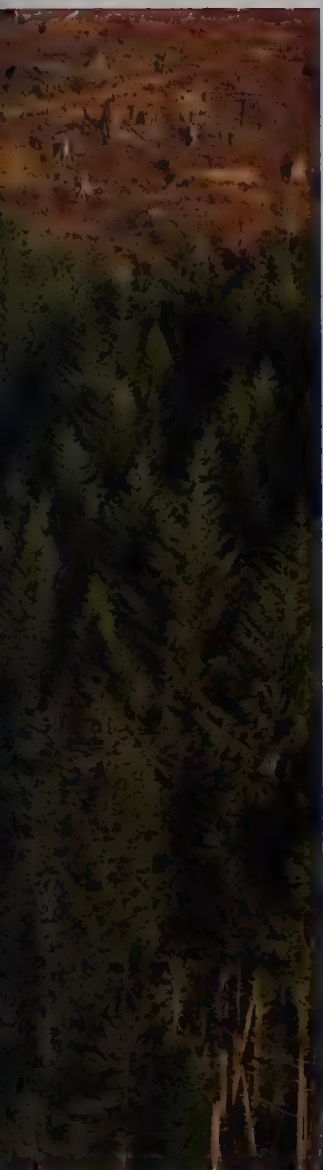
The next quantum leap is the idea that we can, and should, put a dollar value on the environmental assets of the forest. Already, some timber owners, helped by grants from voter-approved initiatives, are going above and beyond what state regulations require in rehabilitating watersheds, decommissioning roads, and stopping erosion. These investments reduce their maintenance costs and help the bottom line while guaranteeing benefits such as cleaner water and healthier fish populations.

Especially promising is the idea that because

forests absorb the greenhouse gas carbon dioxide, timber owners should be paid for the carbon accumulated in their trees. The redwood forest, with its vast carbon-storage capacity, is where many of the first carbon sales have occurred. As new state and federal climate regulations take effect, this market will grow, along with the incentive for timber owners to maximize the standing volume and the productivity of their forests, which produce higher quality lumber the older they get.

The time is right to embrace a systematic plan of recovery for the entire redwood forest—all the pieces are now in place.

THE REDWOODS hold a broader lesson. In 1908 President Teddy Roosevelt brought together the governors of 39 states and territories, the



Clear-cuts eat into stands of 55-year-old spruce, fir, and redwood trees on Green Diamond company land in Humboldt County. California regulations require companies practicing such even-age management to leave buffer zones between cuts and around streams.

Supreme Court justices, virtually his entire Cabinet, and members of Congress and 68 professional societies. Never before or since has such a powerful group been assembled in the White House. Opening the conference, Roosevelt said, "You have come hither at my request...to consider the question of the conservation and use of the great fundamental sources of wealth of this Nation... It is the chief material question that confronts us."

The President tallied the toll on America's resources, including the loss of half our original timber. He made an eloquent call to rebuild the nation's natural capital, or face hardship. He implored those in a position to exploit nature for excessive profit to take the moral high ground instead of robbing future generations.

At that time, a century ago, there were only

about 300,000 white-tailed deer left in the entire United States. Today, even though the human footprint has increased exponentially, there are perhaps 30 million. This rehabilitation, in which states managed hunting, reintroduced the animals in hundreds of places, and restored habitat, has been so successful that many now consider whitetails a pest. The deer story Roosevelt helped inspire is a clear and simple demonstration that conservation can vastly increase the renewable resources we've hammered and wasted since Europeans arrived in North America.

Here is my message: President Obama, convene your own White House conference. The objective would be to build on what's being done in the redwoods and design a Marshall Plan for the proper use of all the natural assets in the United States. People will try to dissuade you, saying we can't possibly afford to think about saving nature when the world is mired in an economic crisis, confronting wars and the threat of nuclear terrorism. President Roosevelt, too, had his challenges—Japan and Russia at war, monopolists to control, the Panama Canal to build—but he understood that conservation was the principal material question facing humanity.

In the 21st century, as we face the consequences of global warming, this is even more vitally true. We need to generalize this simple notion: Rebuild our natural capital thoughtfully and reap the benefits. With increased production for humanity also come healthy ecosystems and global balance. We can—and must—do this not just with our forests and wildlife but also with the fish in our oceans and streams, the soils on our farms, and the grass in our pastures. The redwoods can show us the way. □



Climbing Redwood Giants— a saga of discovery in the world's tallest trees—airs on **National Geographic Channel, September 29 at 10 p.m. ET in the U.S.**

For behind-the-scenes video of how Nick Nichols made his unprecedented photographic portrait of a redwood and for more on Mike Fay's transect, go to ngm.com/redwoods.



They're rarely seen. Even less often photographed.

IN HOT



PURSUIT

Bryde's whales rocket through Pacific shallows to gorge on fish.

Packed fin to fin,
thousands of panicked
mackerel dodge a raft
of hungry sea lions and
a 40-foot-long Bryde's
whale on the hunt along
the coast of Mexico's
Baja Peninsula.

BRANDON COLE





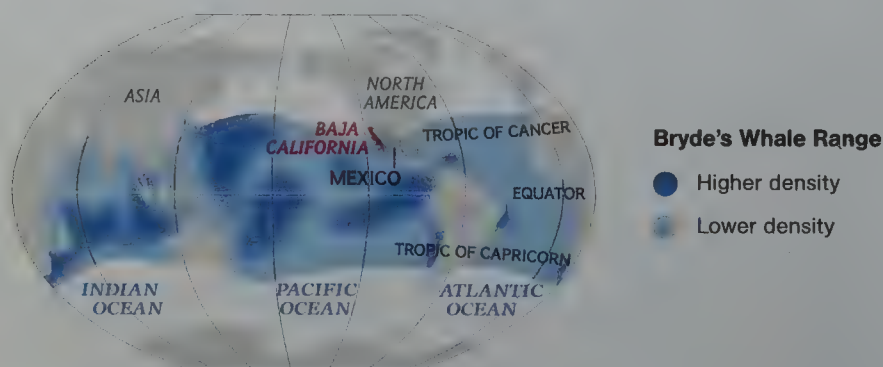
The ocean off Baja erupts like a torpedo range. A long, lean whale shoots up from the deep, chasing thousands of mackerel and sardines as they're driven toward the surface by marlins and sea lions. Suddenly it lunges at the biggest mass of fish, mouth opening wide, throat pouch ballooning with seawater. Even against the tremendous drag created by its gaping maw, flicks of the whale's muscular tail power it through the water. Its jaw snaps shut in an explosion of bubbles. Other hunters circle nearby, waiting for a turn at the feast.

Named for a Norwegian whaling entrepreneur nearly a century ago, Bryde's (pronounced BROO-duhz) are baleen whales, which use meshlike mouth plates to filter food from the sea. "But they're hardly bloated, plankton-straining beasts puttering along at the surface," says photographer Doug Perrine. "They're sleek, predatory missiles," targeting larger, more mobile prey than some other baleen species. Perrine and colleagues were shooting marlins when they saw the rarely photographed whales. Diving with them "was like being on train tracks in the fog," Perrine says, "knowing a high-speed locomotive could appear in an instant," from any direction, without any warning sound.

Surprisingly little is known for sure about this species. Lacking thick layers of valuable blubber, Bryde's weren't much targeted by whalers. They've had scant attention from scientists, in part because they can be tough to find. Bryde's travel solo or in small pods and can dive to a thousand feet. Reported mostly in warm, equatorial waters, they probably breed year-round and may use low-frequency calls to find each other across great distances. But details of their movements, mating habits, and population status are sketchy, and sometimes inferred from better-known kin—making a wild encounter with Bryde's in the vast, blue ocean even sweeter. —Jennifer S. Holland

Built for bursts of speed that may top 18 miles an hour, Bryde's whales can grow 50 feet long and weigh 22 tons—smallish only compared with their colossal blue whale kin. An estimated 90,000 Bryde's live around the globe.

MARC MONTICCHIO



CAITLIN SARGENT; NGM MAPS
SOURCE: HIDEHIRO KATO, TOKYO UNIVERSITY OF MARINE SCIENCE AND TECHNOLOGY





Open wide: A Bryde's upper jaw (at far left) is lined with baleen—hundreds of fringe-tipped plates of keratin, the stuff of other mammals' hair and claws. Baleen traps prey when the whale expels water.

DOUG PERRINE







Stretchy pleats of blubber and skin called throat grooves let a Bryde's underjaw pouch triple in volume as prey-filled seawater rushes in. Voracious eaters, Bryde's whales consume 1,300 pounds or more of food daily.

DOUG PERRINE



Sleek and maneuverable, a Bryde's whale circles a swirling mass of fish as it prepares to seize a meal. Part collaborator, part competitor, the whale joins forces with marlins, sea lions, and other predators to hunt.

BRANDON COLE





INDONESIA

Facing Down the Fanatics

*A more tolerant Islam is confronting extremism
in the world's most populous Muslim country.*

TRADITION DICTATES that girls be shrouded at Pesantren Sunanul Husna, a fundamentalist school in Jakarta.





WOMEN WORK at a West Sumatra gas station. Economic crises have persuaded many Indonesian families



t to rely only on men's earnings. More than half of all women have jobs, a number that grows each year.



THE NATIONAL MOSQUE in Jakarta can hold 120,000 souls for Friday prayers. Arab traders brought Islam



e region a thousand years ago. Now 86 percent of Indonesia's 240 million citizens are Muslim, mostly Sunni.



PILGRIMS attired in special garments symbolizing purity and equality before God prepare to depart for Mecc



st year some 200,000 Indonesians made the hajj, more than from any other nation except Saudi Arabia.

BY MICHAEL FINKEL

PHOTOGRAPHS BY JAMES NACHTWEY



"Live respected or die as a martyr" reads the red-letter motto on the hoods of Front Pembela Islam members. Each year these self-appointed enforcers rally in Jakarta neighborhoods before and during the holy month of Ramadan, intimidating "purveyors of vice" such as bar owners and prostitutes. Last year their leader was jailed for inciting violence.



HE ANSWERS THE DOOR HIMSELF.

No armed guards, no attempt to hide. Abu Bakar Baasyir lives in a modest one-story home on the campus of the boarding school he helped found in the quiet village of Ngruki, amid the central highlands of the main Indonesian island of Java. Baasyir is 71 years old, stalk thin, with a white goatee and lively dark eyes magnified by gold-rimmed glasses. He is the alleged spiritual leader of the militant Islamist group Jemaah Islamiyah, which has been linked to at least a half dozen bombings in Indonesia over the last decade, including the devastating 2002 Bali nightclub blasts and, perhaps, the suicide bombings at Jakarta luxury hotels this past summer.

Baasyir denies involvement in violence and, like a successful mafia don, has avoided a proven connection to any attacks. He served two stints in prison—a total of less than four years—on minor charges not directly related to the bombings. But the Islamic boarding school he established clearly was the hub for a network of jihadists set on creating an Islamic state in Southeast Asia; several of Ngruki's graduates have been convicted of involvement in major bombings. There's little question that Baasyir's teachings have been the inspiration for hundreds, perhaps thousands, of killings and for attacks against "deviant" Muslim groups that fall outside mainstream Islam. Still, he opens his own front door. "Come in," he says, speaking Bahasa Indonesia, the country's official language. "Have a glass of juice."

He is wearing a long, loose shirt, a white skullcap, and a large wristwatch. There are no chairs in his living room and no artwork, just clean white walls, a potted plant, and a low table supporting a plastic container of sesame cookies. He sits on the floor, barefoot, on a grass green rug. His adult son, Abdul Rahim, serves melon juice in tall, clear glasses.

"There is no violence in Islam," says Baasyir, in his deep, gravelly voice, waving his left hand

Michael Finkel reported on Bethlehem in the December 2007 issue. James Nachtwey is a five-time winner of the Overseas Press Club's Robert Capa Gold Medal.

like a conductor. “But if there is hindrance by enemies, then we have the right to use violence in response. That’s what we call jihad. There is no nobler life than to die as a martyr for jihad.” He praises the September 11th and Bali bombings. They were not, he insists, acts of terrorism. They were simply “reactions to what has been done by the enemies of Islam.”

Indonesia is tucked away in a far corner of the world map, a rain of islands just north of Australia, yet violence here can have global repercussions. It is the most populous Muslim country in the world, home to 207 million Muslims—36 million more than the next largest Muslim nation, Pakistan, and two-thirds as many as all the countries of the Middle East combined. It is extremely devout; a recent Pew Global Attitudes survey found that Indonesia was one of the world’s most religious nations. It’s also a thriving democracy, the third largest

in the world, after India and the United States.

But it’s a new democracy, still finding its legs—little more than a decade has passed since the country’s virtual dictator, Suharto, was ousted. The end of his rule granted Indonesians new freedoms of expression, though it also unleashed radicals like Baasyir, who had honed his extremist views during a long exile in Malaysia, where he’d fled after his arrest for opposing Suharto. A year after the 2002 Bali bombings came the first J. W. Marriott hotel bombing in Jakarta, then in 2004 a strike on the Australian Embassy, also in Jakarta, and in 2005 a triple suicide attack, again in Bali. And just a few months ago, after a long gap during which many experts came to believe that the threat of terrorism was greatly reduced, came the bombings at the Ritz-Carlton Hotel and, once more, the J. W. Marriott. These are scattered events in a vast nation. But in the words of one Indonesian proverb, roughly translated,

In 2001 the government designated Aceh a Special Autonomous Region, allowing the province to implement sharia as part of its criminal code.

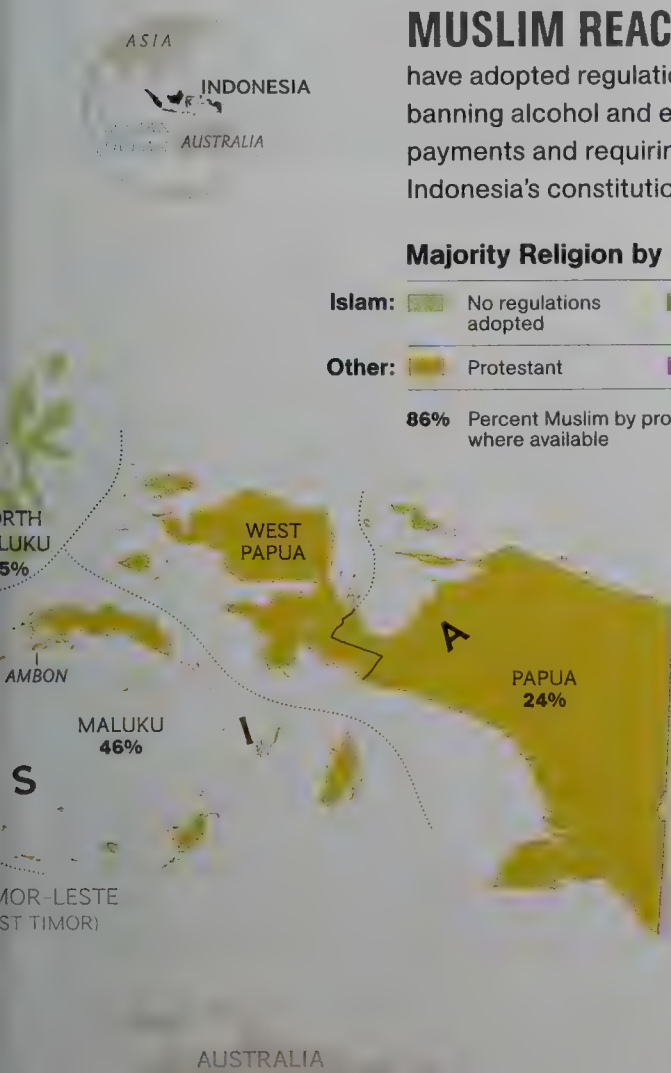


“It takes just a little poison to spoil all the milk.”

Indeed, Indonesia’s 17,500 islands can feel, at times, like so many marbles on a wobbly table. A subtle tilt, and they’ll all roll in one direction. As recently as 2005, Indonesia seemed to be tipping toward Islamic radicalism, feeding Western fears that it was becoming a haven for terrorists. For several decades, Indonesian society had been growing more overtly Islamic: Attendance at mosques swelled, and Muslim dress became popular. In the late 1990s, a growing number of district governments began enacting regulations inspired by sharia, or Islamic law, and support for Islamic political parties was on the rise. Increasingly, militant Islamic groups that advocated a violent struggle to recast Indonesia as an Islamic republic seemed to be drowning out the voices of the majority of Indonesian Muslims, who believe that their faith can smoothly coexist with modernity and democratic values.

But in the past few years, although Indonesians continue to embrace Islam in their private lives with greater fervor, it’s become clear that most don’t want religion to be enforced in the political sphere. “So many people equate Muslim piety with radicalism,” says Sidney Jones, an Indonesia specialist with the nonprofit International Crisis Group who has lived in the country for more than 30 years. “Indonesia is full of examples of why that notion is wrong.” As Islamist politicians have moved to regulate women’s dress codes and ban activities like yoga, moderates have begun to make their voices heard. In the Indonesian parliamentary elections this past April, candidates backed by Muslim organizations received less than 23 percent of the vote, down from 38 percent in 2004.

Though the recent bombings are a setback, Indonesia has lately been seen as a success story in how to curb violent extremism. Authorities



MUSLIM REACH Since 1998 many districts and some provinces have adopted regulations inspired by sharia—Islamic law. These range from banning alcohol and enforcing dress codes to compelling Islamic alms payments and requiring Koranic literacy. Critics say such rules subvert Indonesia’s constitution, which ensures religious freedom for all.

Majority Religion by Province

Islam:		No regulations adopted		Sharia-inspired regulations at the district or provincial level		Whole province has adopted sharia
		Protestant		Roman Catholic		Hindu

The World’s Largest Muslim Populations
2009 estimate, in millions

Indonesia	207
Pakistan	171
India	145
Bangladesh	138
Turkey	76
Egypt	75
Nigeria	75
Iran	65

have arrested at least 200 members of Jemaah Islamiyah in the past five years, although some dangerous fugitives remain at large. Many radicals have shifted to advocating the establishment of Islamic law. Even Abu Bakar Baasyir, since his release from jail in 2006, has distanced himself from more militant factions of Jemaah Islamiyah and begun promoting the struggle for sharia as the way for Islamists to achieve their goal of transforming the democratic nation into an Islamic republic.

Baasyir believes that any human-created law-making body—a house of congress, a court of law—is an insult to the sovereignty of God. “Allah has sent a manual on how to treat human beings,” he says. “That manual is the Koran.” There’s no need, in his view, for any other code. “Islam and democracy,” he concludes, “cannot coexist.” Now that Suharto is out of power and centralized rule has been weakened, local districts

the way for Aceh to become the nation’s first province to establish sharia as criminal law.

Devi Faradila is a fashionable, 35-year-old mother of two and a parliamentarian in Aceh Province. At the time of my visit, she was the leader of the all-women’s unit of the Banda Aceh Sharia Patrol, a municipal force in charge of monitoring compliance with local rules in the province’s capital. On a typical Friday—a day, according to Aceh law, when all Muslim men must attend mosque—Faradila readied her unit for duty, breaking up a Ping-Pong game in the station house, wagging her finger at a couple of text messaging officers.

Faradila and 13 patrollers donned black baseball caps to complete their uniforms—black shoes, black slacks, black blouses, and lime green head scarves—and piled into a pickup equipped with loudspeakers. Faradila, in the driver’s seat, pulled on leather gloves, added a

INDONESIAN ISLAM MELTS WITH A MULTITUDE OF TRADITIONS. ONE GROUP EVEN DRINKS WINE IN ITS CELEBRATIONS, THOUGH THE KORAN WARNS AGAINST IT.

can decide for themselves whether to institute sharia-based regulations. Where this has been done, Baasyir says, everything is better. Much better. “Go see for yourself,” he says.

THE PROVINCE OF ACEH, on the western prow of the Indonesian archipelago, is now perhaps best known for suffering a direct strike from the December 2004 tsunami, which killed more than 160,000 Indonesians. But for centuries, the Aceh region has been recognized as one of the most devout Muslim areas in all of Asia. Aceh’s unofficial slogan is that it is the “veranda of Mecca,” and many of its residents seem to sit on this porch with their backs to the rest of Indonesia, embracing an Islam closer to that which exists across the ocean on the Arabian Peninsula. Here, more than anywhere else in the islands, people observe a strict Islamic code of conduct. In 1999 the national government paved

fresh coat of lipstick, and put on mirrored sunglasses. Her deputy hopped in beside her. The rest of the women sat in the bed of the pickup.

The truck moved slowly through the city, Faradila blasting a constant stream of announcements over the speakers. “Hurry up, men! Friday prayers are about to begin.” “Stop all activities. It’s time to pray.” Men on the streets or in shops—a carpet seller, a furniture maker, a fruit vendor, a bricklayer—turned their heads and stared. A few checked their watches. “Today is Friday. It is obligatory for men to pray.”

Aceh is the only Indonesian province with a sharia patrol unit; a total of 800 officers, mostly men, police the region day and night. But at midday on Fridays, the Muslim Sabbath, sharia enforcement is left to the women, who can pray at home. Faradila wove the truck around the massive five-domed mosque at the city center, then toward the shoreline, which was both

Romaeni binti Hasan Basri (second from left) began wearing a chador during her last semester studying theater at the Jakarta Arts Institute. Her friends teased: "Are you growing a mustache?" But they got used to it. "Faith is a process," she says. "I'm going through the process, with or without the chador."



gorgeous, with mountains rising green from the sea, and haunting—giant swaths turned to swampland by the tsunami. One officer in back spotted a teenage girl strolling down a sidewalk with no head scarf, a reckless act in a city where virtually every Muslim woman is covered. The truck immediately screeched to a halt. "Veil! Veil! Veil!" the officers shouted. The girl looked aghast. She indicated in pantomime that she would put a covering on, and the truck drove off.

As prayer time grew near, Faradila's pleas became less polite. "Close your shop!" "Find the nearest mosque!" The truck pulled over in front of a dilapidated two-story building, a fish market and artists' studio, a known place for drinkers. The team leaped out of the truck—half Charlie's Angels, half Taliban. Two men were swiftly nabbed. They were fishsellers, they said, and smelled too bad to attend a crowded mosque.

The women issued them citations anyway.

A widely distributed booklet, *A Brief Look at Sharia Islam in Aceh*—the cover shows a man being whipped—outlines the rules. If you're caught gambling: six to 12 lashes. Improperly mingling with the opposite sex: three to nine lashes. Drinking alcohol: 40 lashes. Skipping prayer on three consecutive Fridays: three lashes. The whip, according to the booklet, must be made of rattan a quarter to a third of an inch thick. At the Banda Aceh Sharia Patrol station, two whips were on display, each as long as a cane and as snappy as a flyswatter. There was a photo album filled with images of the whippings; more than a hundred have taken place since 2005. The man who administers them wears a maroon robe, white gloves, and a face-covering hood. The crowds are enormous.

Polls indicate that, although most Indonesians say they want sharia as the foundation of



MIRRORING THE PROPHET, the men at one An-Nadzir commune in South Sulawesi shun technology, tie



ir turbans and dye their hair as they think Muhammad did, and condemn all forms of violence.

A model vamps at a photo shoot for *ME Asia*, a magazine challenging Indonesia's moral conservatism. The 2006 arrival of a local, nudity-free edition of *Playboy* reignited national debate over censorship and decency. *Playboy* folded, and a new antipornography law passed, but some publishers are testing its bounds.



public life, they are uneasy about the imposition of such corporal punishments. Outside of Aceh, adoption of religious-based regulations has been piecemeal, with some districts prohibiting gambling or drinking, or requiring women to wear veils. Yet these rules have often been enacted by secular politicians who see Islamic regulations as a way to curry favor with their pious constituents or distract attention from ongoing corruption. In the future, experts say, playing the “Islam card” may not have the populist force it did just three or four years ago.

Except, perhaps, in Aceh, which appears to be ratcheting up its Islamization and has even considered implementing the surgical severing of hands in accordance with the Koran's punishment for theft. That would be fine with Faradila. Sharia law, she insisted, has made Banda Aceh more reverent and much safer. She'd like to see an expansion of the laws. “Cutting hands,” she

said, “in the correct circumstances, would serve as a lesson to others. Crime would be greatly reduced.” Stoning for adulterers would also be fine. “When you embrace Islam,” she said, “you have to embrace all the laws.”

FUNDAMENTALIST ISLAM is a fairly recent import to Indonesia, where a relaxed if no less fervent form of the religion has long held sway. “Smiling Islam,” it's often called. Islam originally came here the way most things come to islands—by sea. The islands' volcanic soil is ideal for growing spices, and by the 12th century most of the traders taking Indonesian pepper and nutmeg and cloves to the West were Muslims from the Middle East. For Indonesian producers, converting to Islam had advantages—trading partners preferred fellow believers.

The spread of Islam into Indonesia was gradual and peaceful. What took one frenzied,

blood-soaked century in the Middle East required a leisurely half millennium in Indonesia. Scattered across some 3,000 miles of ocean, the islands had hundreds of ethnic groups and religious practices. Islam helped integrate previously separate peoples into a single regional culture. By the time the United East India Company, run by the Dutch, won control of the spice trade in the 17th century, Islam had spread to nearly all of Indonesia's coastal societies. "Islam was so successful coming to Indonesia because it was able to accommodate the existing culture and religions," says Syafii Anwar, executive director of the International Center for Islam and Pluralism in Jakarta. "Even in the architecture of the mosques, local style was incorporated."

Yet when the global reshuffle following World War II opened the path to independence from Dutch rule, Indonesia's first president, Sukarno, chose not to establish an official state religion.

away its regional flavor. That clash continues today, fueled in part by ideas and practices originating in the strict Wahhabism of Saudi Arabia, which has funded Islamic universities and boarding schools throughout Indonesia.

Still, across most of the country Islam continues to meld with a multitude of indigenous faiths and traditions. Rhythmic drumming, once associated strictly with native ceremonies, is often used before the Muslim prayer call, introducing the standard chant broadcast from mosque minarets. An Islamic group on Lombok Island even drinks a traditionally made palm wine in its celebrations, though the Koran warns against any alcohol consumption.

PERHAPS THE QUINTESSENTIAL expression of Smiling Islam can be found in Jakarta, Indonesia's messy, manic capital, where extravagant malls and cinemas with names like Hypermart

**"CUTTING HANDS," SAID FARADILA, "WOULD SERVE AS A
LESSON TO OTHERS. CRIME WOULD BE GREATLY REDUCED."
STONING FOR ADULTERERS WOULD ALSO BE FINE.**

Creating an Islamic republic, he felt, would alienate the minority of the population that was not Muslim; Sukarno himself had a mother of Balinese Hindu ancestry and a Muslim father. Indonesia's second president, Suharto, took power in 1966, in the wake of explosive anti-communist violence that killed half a million people, and for a while he was able to smother the hostilities and foster economic growth. But his regime was repressive and militarized. Suharto's resignation, in 1998, was triggered by a student-led, largely Muslim pro-democracy movement a few million strong—a development that some historians have cited as a landmark event in contemporary Islam.

But the end of Suharto's regime also intensified a schism within the Muslim community between those who supported the nation's traditional blending of Islam with local beliefs and those who sought to "purify" Islam, stripping

and Blitzmegaplex are under construction, and luxury high-rises abut teeming slums. Here, on a gravel side street, is the dusty, cluttered office of Ki Demit. *Ki* is the honorific bestowed upon Indonesian mystics. Ki Demit, whose name means Little Ghost, is 28 years old, baby-faced, and the son of another *ki*—Big Ghost—as well as the grandson and great-grandson of mystics. "I come from the most magical bloodline in Indonesia," he says.

In most places across the Middle East, such a statement would be heretical—anything paranormal not attributed to Allah is forbidden in Islam—but inscribed on a black batik in Ki Demit's waiting room is the menu of his charms. These include *santet* (sending a hex), *pelet* (gaining a lover), *kekebalan* (immunity from injury), and *kejantanan* (prowess in bed). One wall is covered with photos of celebrities—a soap opera star, a singer, a comedian—who



A BLIND STUDENT reads at Yayasan Raudlatul Makfufin, a school and foundation in South Jakarta that



tributes Braille Korans for free. Such Islamic charities form part of the safety net for less fortunate Indonesians.

have sought the help of Ki Demit or his father.

Ki Demit's clients sit cross-legged on the floor in front of him, a creaky ceiling fan above, the room crammed with candles and perfume bottles and prayer beads and antique knives. "I can read people's minds, and I can see the future," he says. "But I don't want to compete with God. I am only God's mediator." At the conclusion of many of his sessions, he'll give a client a handful of dried flowers he says are imbued with supernatural powers. Once the client takes a bath with the flowers, he says, his spell begins.

"I'm a good Muslim," insists Ki Demit. "Of course I pray five times a day. Of course I observe Ramadan. But long before Islam came to Indonesia, my ancestors were practicing these rituals. My father trained me as a ki, and when I have a son I will, of course, train him. I embrace Islam strongly, but I hold tightly to my powers. You cannot play with this power."

Her talk show, which featured movie stars, musicians, and athletes, set the conversational tone of Indonesia—her otherness, in a way, allowed her to openly express what might ordinarily be left unsaid. She chatted about marital troubles, spoke candidly of sex. ("Women, if you want to make love, don't wait for your man to offer. Go ahead and ask for it.")

In her dressing room after one show, she kicked off her shoes and greeted a stream of well-wishers. A 19-year-old boy told her, "I like your show because you are cute." A 90-year-old woman said, "I just want to kiss you." All the while, she rarely stopped talking, reminiscing about her early days in show business, when she served as the in-flight entertainment on chartered flights to Mecca. Only in Indonesia could a transsexual troubadour be deemed an appropriate diversion for hajj pilgrims.

"I'm a normal person," she said. "I behave as a

"THE MESSAGE WAS THAT IF I WANTED TO GO TO HEAVEN, I HAD TO JOIN THE SQUAD," SAYS ISMAIL. "IT'S SHOCKING THAT MORE OF US DIDN'T TURN TO EXTREMISM."

ACROSS TOWN from Ki Demit is the television studio where singer and talk-show host Dorce Gamalama recorded her daily show (before it ended this past May). She's the Oprah of Indonesia, widely known by her nickname, Bunda, which means "mother." She taped her show in front of a studio audience of mostly middle-aged women in head scarves—conservative Muslims seem to be her biggest fans, perhaps because Dorce herself, beneath the buzzy energy and megawatt smiles, is a devout Muslim. Near her home in Jakarta, she's built her own mosque.

Oh, and one more thing: Dorce was born a male. She's a transsexual. She's had her "condition," as she calls it, all her life and had a sex-change operation in her 20s. She's been married twice, both times to men. She owns 300 pairs of shoes and a thousand wigs. She sings, dances, and tells mildly risqué jokes. She's not above taking the occasional comedic pratfall.

woman. I'm even prudish! There's no sex with me before marriage." When asked if her faith always comes before her career, she looked insulted. "My life," she told me, "is for God."

THAT'S WHAT EVERYONE SAYS: the militant, the mystic, the sharia cop, the TV star. United in their devotion to God, divided on how, precisely, one should express that devotion. The version of Islam that captures the minds of the next generation—the tolerant Smiling Islam or the austere and sometimes violent brand advocated by extremists—could determine the path Indonesia takes and perhaps provide a model for the future of global Islam. One place to gauge its direction is at the country's Islamic boarding schools, particularly the one located at the end of a bucolic lane in Ngruki, where Abu Bakar Baasyir teaches.

The school is actually a lovely place, buildings of white-painted brick capped by red- and

Before his execution in November 2008, Mukhlas, part of an al Qaeda-aligned group, remained gleefully defiant. In 2002 he helped plot bombings on Bali that killed 202 people. Other attacks followed, including blasts this past July. Police have arrested or killed scores of militants, including two of Mukhlas's brothers.



blue-tiled roofs. Outside the gate a man sells ginger milk from a bicycle-pulled cart. In front of the school's mosque, in the center of campus, an array of gum-ball-colored flip-flops are stuffed into wooden cubbies. Shouts echo across the basketball court. About 1,500 students, slightly more girls than boys, attend the school, which offers education at the junior and senior high school level. Students live in dorms, 20 to 30 per room, and sleep on mattresses on the floor.

Noor Huda Ismail is a former student at Ngruki, now 36 years old and an expert on security issues in Southeast Asia whom I hired to help set up interviews for this story. After the first Bali bombing, Ismail says, the Indonesian government sent an investigative team to Ngruki. The results were inconclusive. "There was nothing specific to terrorism in the curriculum," says Ismail. "The public face of Ngruki was like any other. There was nothing at

all clandestine—unless you were 'picked.'"

While at Ngruki, Ismail was, in fact, picked. "My indoctrination took place outside of class," he says. "It began with small meetings, teacher-student meetings during sports, during day hikes. I was told that our enemies are strong." He was an ideal candidate, he believes, due to his ability to speak English and Arabic.

"Just before I graduated," says Ismail, "I was invited to one of the teacher's houses. I sat on a mat on the floor. The light was low. There were three of us students there. The message was that Islam is your only possible salvation, and if I wanted to go to heaven, I had to join the squad. I was 15 years old." One of Ismail's roommates was Hutumo Pamungkas, who is now serving a life sentence for his participation in the Bali bombings. "It's shocking that more of us didn't turn to extremism," Ismail says.

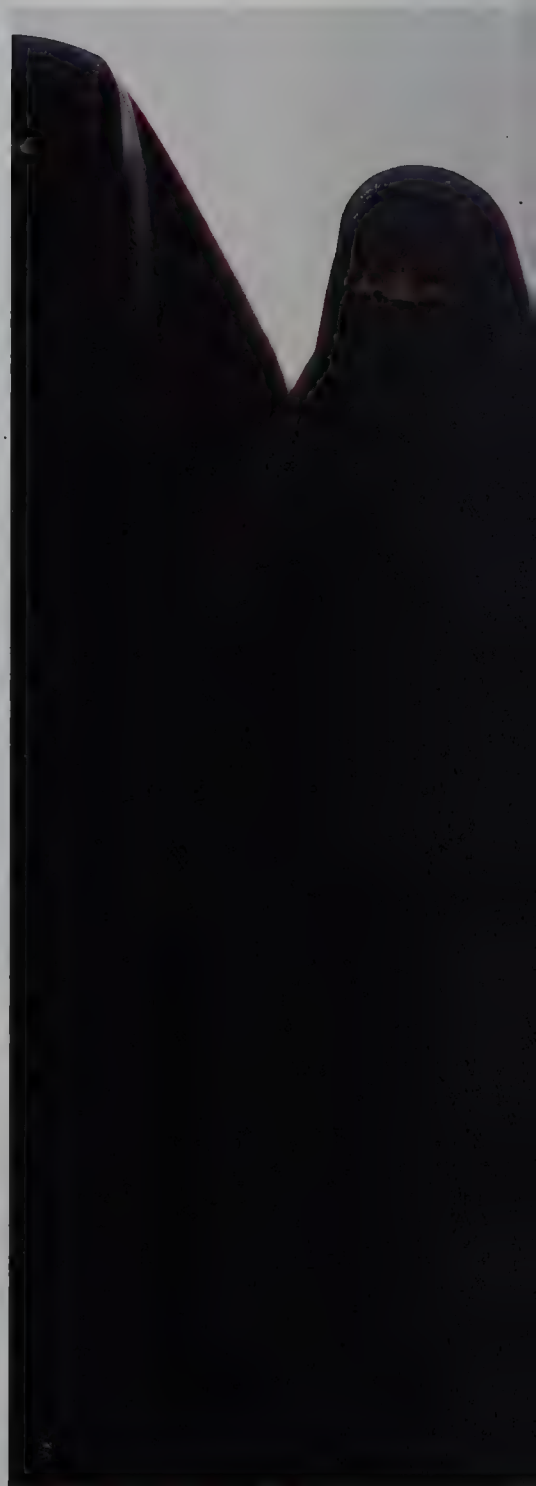
Robert W. Hefner, an anthropologist who

has studied Muslim politics in Indonesia, believes that Islamic extremism has lost much of its momentum in the archipelago, though it may be impossible to stop all attacks. Significant credit belongs to the Indonesian police, who have not only arrested hundreds of violent Islamists but have also successfully “deradicalized” some imprisoned militants by offering them conjugal visits and scholarships for their children. But the change is also the result of a decades-long effort by Islamic educators to implement reforms in their schools. Since 2004, all students entering the state Islamic system are required to take courses on civics, human rights, and democracy. Even Ngruki, despite its reputation as a hotbed of radicals, accepts the government’s guidelines.

Ultimately, Indonesia may be simply too big and diverse to adhere to any narrow definition of Islam. Even something as secular as one Indonesian takeoff on *American Idol* can be a platform for Islamic variety. During a recent season, the final two contestants were both Muslim women. One wore a veil, one did not. No one seemed to care. Indonesia’s national motto, after all, is “*Bhinneka tunggal ika*—Unity in diversity.”

“Islam in Indonesia is a huge tent under which all voices can talk to each other,” says Robin Bush, of the Asia Foundation. Fringe groups, she points out, can receive an inordinate share of media attention and frighten people away from publicly denouncing them. They can even send suicide bombers into hotels. But their reach has not extended into the ballot box.

Of course, that could change. Continued government corruption, another Suharto-like leader, a charismatic imam who can rally the disaffected—any of these might shift Indonesia’s balance. “If our secular government fails to deliver, Jemaah Islamiyah will have fodder to recruit,” says Ismail. “I think we are going to be constantly in flux,” he adds. “When the Western influences get too strong, the Islamist elements will get louder. When Islamist voices get too loud, the more secular voices will be raised. It will always be that way. Up and down. Up and down. Welcome to Indonesia.” □





Facing the dawn, women of the An-Nadzir commune begin Islam's Feast of the Sacrifice, which celebrates the Koran's account of God sparing the prophet Ismail. As the sun rises, their prayers join those raised by a chorus of Indonesia's Muslims, fundamentalist and moderate alike: "*Allah akbar*." God is great.



In the heart of the Sahara, water from rains that fell millennia ago pools in the Waw an Namus volcanic crater. Winds carried black ash from the last eruption 12 miles out across the desert.

Unseen

A RARE AERIAL LOOK AT LIBYA'S REMOTE FEZZAN REGION

An aerial photograph of the Sahara Desert. The foreground is dominated by a vast, dark, and textured expanse of sand, showing numerous parallel ridges and grooves. In the upper left, a small, irregularly shaped oasis with blue water is visible, surrounded by patches of green vegetation. The background shows more of the desert landscape under a hazy, blue sky.

Sahara

HERE ANCIENT SOCIETIES THRIVED AND COLLAPSED AS THE RAINS CAME AND WENT

Even half submerged in dunes, sandstone pinnacles dwarf a truck (lower right) at Maridet. Long ago, in a green Sahara, tropical rains dissolved surrounding rock, helping create spiky peaks.







Date palms and reeds fed by an underground aquifer fringe the shore of Umm al Maa, one of about a dozen salty pools in the Ubari Sand Sea—reminders of the ancient Lake Megafezzan.





Cut into rock at Wadi Matkandush 5,000 years ago, before the rains ceased and the Fezzan turned arid, sparring wildcats may have evoked the powers of fierce carnivores for humans who hunted here.



An ancient wind is coming up from a place called deep time. The Sahara strikes us as an eternal inferno of dunes and blue sky. We are dazzled by its vistas but fail to notice it as one of the great record-keeping places on Earth. The past survives here and speaks from the sand, rock, heat, and dry winds. It whispers to us about a history of repeated jolts of climate change and of the advance and retreat of humanity.

David Mattingly heads a team of scholars on the Desert Migrations Project, whose work takes us to prehistory. They are time travelers who use four-wheel-drive vehicles to navigate the Sahara looking for traces of our forebears. With special tires deflated to provide extra traction, they conquer dunes up to a hundred feet high. They have opened up a whole new way to see this desert.

In the southwest part of Libya, a region called Fezzan is the beating heart of the Sahara, an inaccessible place full of sand seas, wadis, mountains, plateaus, oases, and mystery. Between 500 B.C. and A.D. 500 an estimated 100,000 people farmed and thrived here, in an area that typically receives less than an inch of rain a year and many years none at all.

“That,” Mattingly notes, “is an awful lot of people in the hyperarid landscape of the central Sahara.”

An archaeologist at the University of Leicester, he’s become a slave to the desert: “I’ve been working in Libya for 30 years, and from the start I was wowed by the landscapes.” Many others have known this fate. They become addicted to brilliant light and uncluttered horizons. Where most see a wasteland, others find clarity.

Hugh Clapperton, a Scottish explorer, plunges into the desert of southwestern Libya between 1822 and 1825. He is the point man of an empire, the face of steam power, spinning jennies, and the British fleet. On November 7, 1824, he is crossing the dry ground when he comes upon a female slave left “to perish on the road today, her head was terribly swelled & unable to walk & insensible.” Clapperton finds one of the master’s servants huddled by the woman,



JEROME N. COOKSON, NG STAFF

“waiting by her until she died, not to bury her but to bring away the few rags she had on.”

She cannot ride a camel; she is too weak to hold on. He thinks if he lingers, he will die too.

The wind is cold, he notes.

He rides on.

This is the Sahara of dread. A waterless sea of sand and stone, where scorpions infest, vipers slither, and the sun has no mercy. Libya is big—a slab of sun the size of Italy, France, Spain, and Germany—and almost all of its six million people live huddled on the Mediterranean coast. To truly understand the region, we must turn our backs on the sea and look south. Ninety-five percent of Libya is desert, 20 percent is dunes, and not a single perennial river runs through it. The Libyan Sahara holds the world’s heat record (136°F) and can chill the bones on a winter night.

Ibrahim al-Koni, Libya’s leading novelist, was raised as a Tuareg in the Fezzan. In his book *The Bleeding of the Stone*, he quotes a Sufi song:

*The desert is a true treasure
for him who seeks refuge
from men and the evil of men.
In it is contentment,
in it is death and all you seek.*

The Fezzan reveals thousands of years of life struggling against change, of humans adapting to a hostile environment. It is a time machine where the past slaps us in the face, and if we linger, things happen to our safe ideas.

We moderns have grudgingly accepted that the past is a record of shifts in climate, great migrations, the rise and fall of nations, yet we act as if our present is the final chapter. But in the Sahara a very long tale confronts any visitor, a reminder that this current chapter is thin and fragile.

Mattingly’s investigations bring him to the Ubari Sand Sea, where there are, improbably, many tiny, gem-colored lakes—some purple, some orange from minerals and algae—that are the dried-up reminders of a previous time when groundwater lay closer to the surface than it does today. It’s hard to imagine, but a lake the size of England, Lake Megafezzan, gleamed here about 200,000 years ago, when rainfall was abundant, and ancient channels testify that rivers ran in the center of the desert.

Climate change has been like an on-off switch in the Sahara. In dry times the lakes dwindled and the plants declined to niches. Then, when moister times returned, the lakes filled and parts



Traffic accidents are few, but billboards featuring Libyan ruler Muammar Qaddafi are everywhere in Fezzan's major city, Sabha, where less than half an inch of rain falls yearly. Beyond the city and a handful of towns lies the roadless Sahara.

of the Sahara were transformed to savanna. Human communities have pulsed here like the explosion of plants after a rare rain. When moist eras visited, they thrived. When the dry times returned, they shrank or collapsed.

How does one locate waterways of long ago? From way up high. Using radar images taken from space, Migrations Project team members Kevin White and Nick Drake have been able to map the location of mineral residues from ancient lakes and springs, then steer their Land Rovers to those spots, where paleoanthropologists Robert Foley and Marta Mirazón Lahr discovered stone tools, arrowheads, fireplaces, graves, and other clues to human occupation.

The earliest modern humans in the region were hunters and gatherers who lived in a savanna landscape about 130,000 years ago. Those people cleared out when the rains tapered off about 70,000 years ago, but then the rains returned and people moved in again. This back-and-forth migration is called the Saharan pump, a movement of people in and out of northern Africa as the climate shifted. Scratched on the desert's rocks are the memories of a wetter Sahara, when water-dependent creatures such as

lions, elephants, and rhinoceroses lived here.

A funny thing happened when the most recent wet phase ended. About 5,000 years ago the rains stopped once more, the lakes disappeared, and the desert took hold. Yet this time the people stayed. Rock art suggests they had already made the transition from hunting to raising livestock. Next came the rise of a society that would begin building towns and make the transition to agriculture: the Garamantian civilization.

The Garamantes flourished here in a climate much like that of the Sahara today. Many scholars assumed they were desert nomads, but excavations at their capital city, Garama (near modern-day Jarmah), and land surveys by Mattingly's team have shown they were sedentary people living off oasis agriculture. They constructed a sophisticated irrigation system that allowed them to grow wheat, barley, sorghum, date palms, and olives. Underground canals—called *foggaras*—tapped into

Charles Bowden is the author of Killing the Hidden Waters. George Steinmetz made the aerial pictures for this story from his motorized paraglider, which he assembled after his arrival in Libya.



Carefully chosen light and dark stones mark the isolated grave of a herder who died between 5,000 and 3,000 years ago. As rainfall dwindled, Fezzan's inhabitants congregated around scattered oases.



groundwater and directed it to fields without loss to evaporation. Six hundred miles of these canals can still be detected. The system worked well for hundreds of years. And then the “fossil” water, stored up in wet times, started to give out, and the civilization collapsed.

The Sahara seems like a barrier at first glance, severing Africa into two pieces. But for the humans who have lived in Libya for thousands of years, it has been a corridor. Gold and ivory and slaves came north from sub-Saharan Africa; olive oil, wine, glass, and other goods from the Mediterranean flowed south. This trade creates a lasting image in our minds: the caravan winding its way through huge dunes.

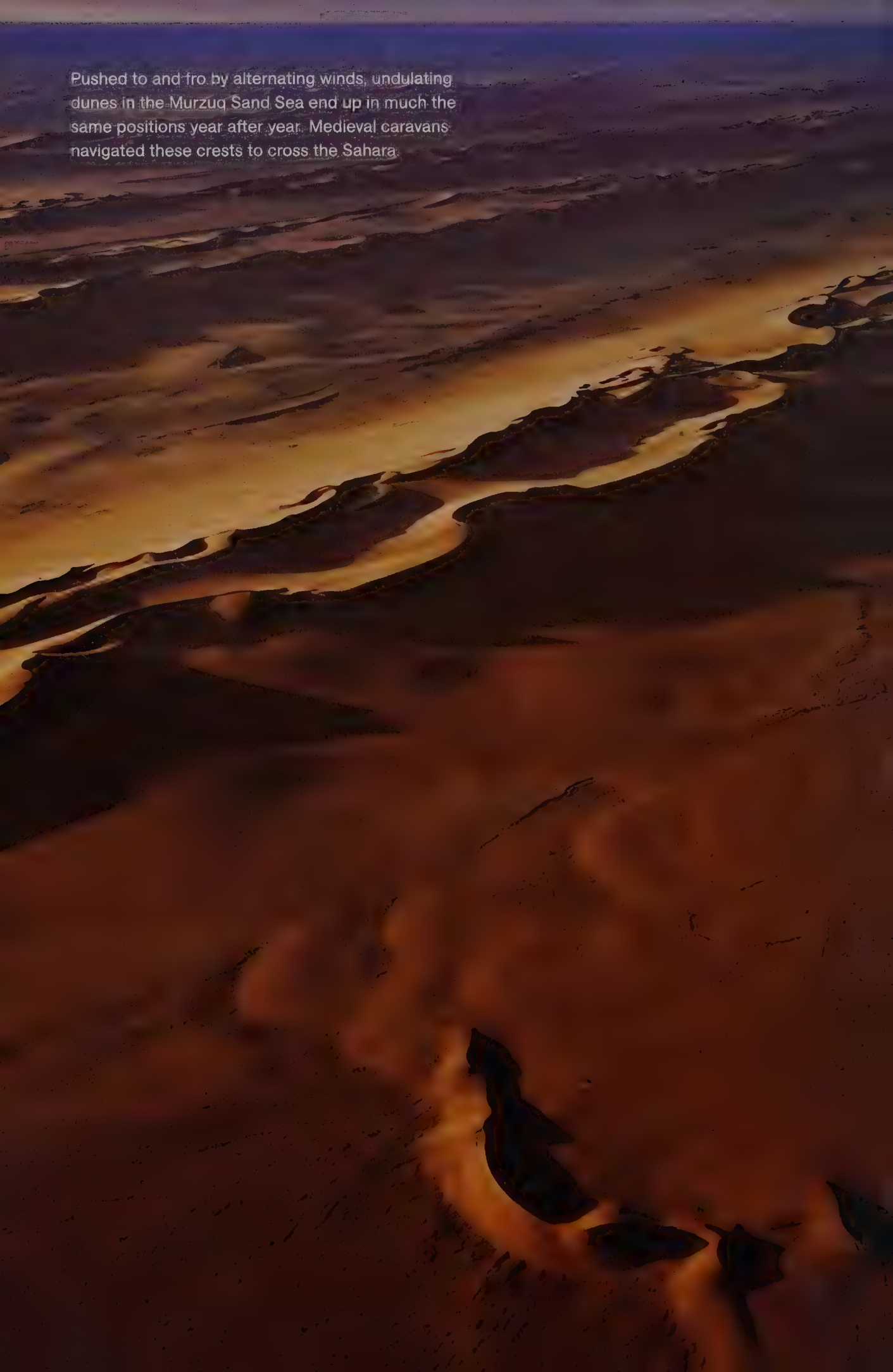
The Saharan corridor may even have been one of the pathways our ancestors followed when they left the eastern part of the continent to populate the rest of the world. Scholars have long assumed that early humans expanded beyond sub-Saharan Africa into Eurasia by migrating either along the Nile River and across the Sinai or across the Red Sea. Now another notion is being explored: that the Fezzan may have been part of a long migratory corridor leading some modern humans to the shores of the Mediterranean and from there across the Sinai. Perhaps, through this sea of sand, our ancestors trekked from the Great Rift Valley and into our lives.

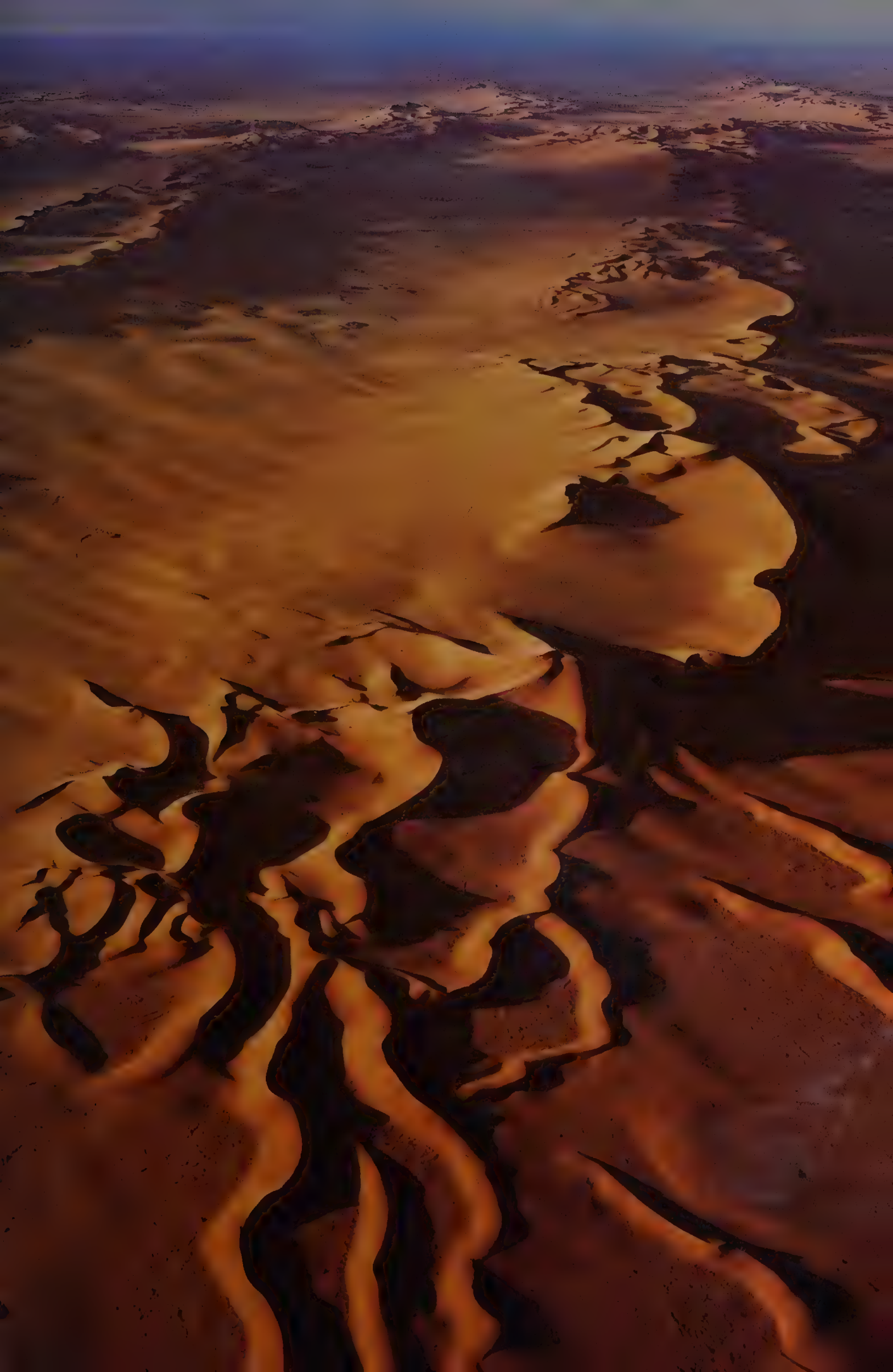
Mattingly says he likes archaeology because “it has lessons for today.” Fifteen hundred years after the fall of the Garamantes, the Libyan government is now building the Great Man-Made River, a series of huge aqueducts to mine ancient underground water reserves below the Sahara and use them to make the desert bloom. The water being pumped was deposited tens of thousands of years ago, in much wetter times. Already the water table is declining because of the pumping. The project has an estimated life span of only 50 to 100 years, a blink of the eye in this region.

Clearly the last chapter of the Fezzan is yet to be written. □

Society Grant The photographer's expedition was funded in part by your National Geographic membership.

Pushed to and fro by alternating winds, undulating dunes in the Murzuq Sand Sea end up in much the same positions year after year. Medieval caravans navigated these crests to cross the Sahara.







Sand powered by strong winds carved an arch in the Akakus Mountains. A drying climate forced ancient people to retreat, leaving Fezzan's parched beauty quiet under desert skies.





SHIPWRECK
IN THE

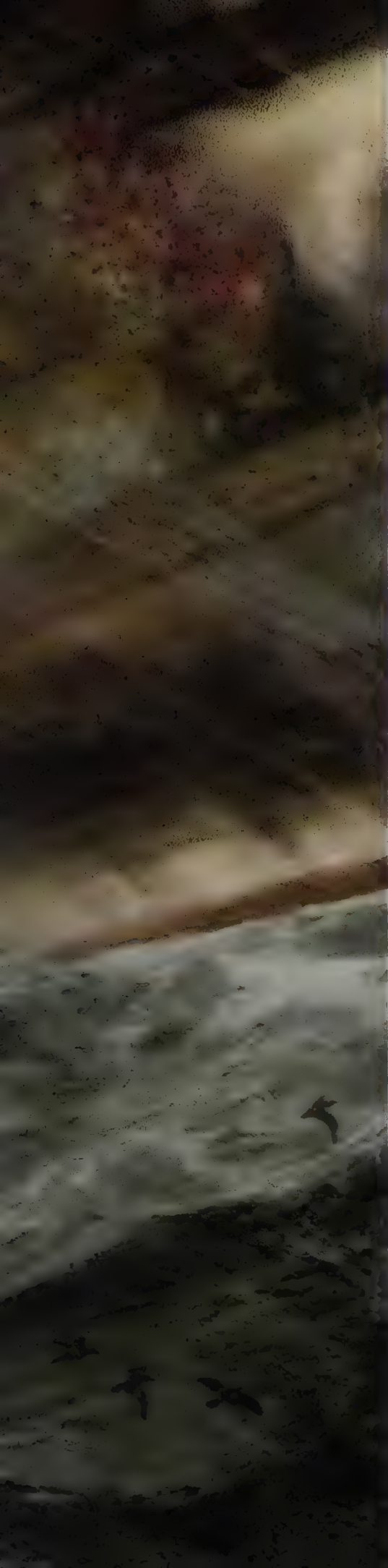
FORBIDDEN ZONE

Five centuries ago a ship loaded with gold
wrecked off a beach laden with diamonds.

LOST IN 1533, A SPANISH EXCELENTE COMES TO LIGHT AT A MINE IN NAMIBIA.







BY ROFF SMITH

PHOTOGRAPHS BY AMY TOENSING

ART BY JON FOSTER

History rarely unfolds like a fable. But consider this: A 16th-century Portuguese trading vessel, carrying a fortune in gold and ivory and bound for a famed spice port on the coast of India, is blown far off course by a fierce storm while trying to round the southern tip of Africa. Days later, battered and broken, the ship founders on a mysterious, fogbound coast sprinkled with more than a hundred million carats of diamonds, a cruel mockery of the sailors' dreams of riches. None of the castaways ever return home.

This improbable yarn would have been lost forever had it not been for the astonishing discovery in April 2008 of a shipwreck in the beach sands of the Sperrgebiet—the fabulously rich and famously off-limits De Beers diamond-mining lease near the mouth of the Orange River on Namibia's southern coast. A company geologist working in mining area U-60 came across what at first he took to be a perfectly round half sphere of rock. Curious, he picked it up and immediately





realized it was a copper ingot. A strange trident-shaped mark on its weathered surface turned out to be the hallmark of Anton Fugger, one of Renaissance Europe's wealthiest financiers. The ingot was the type traded for spices in the Indies in the first half of the 16th century.

Archaeologists would later find a staggering 22 tons of these ingots beneath the sand, as well as cannon and swords, ivory and astrolabes, muskets and chain mail—thousands of artifacts in all. And gold, of course, fistfuls of gold: more than 2,000 beautiful, heavy coins—mainly Spanish *excelentes* bearing the likenesses

of Ferdinand and Isabella, but also a smattering of Venetian, Moorish, French, and other coinage, as well as exquisite portuguesees with the coat of arms of King João III.

It is by far the oldest shipwreck ever found on the coast of sub-Saharan Africa, and the richest. Its dollar value is anyone's guess, but none of its treasures have fired the imaginations of the world's archaeologists as much as the wreck itself: a Portuguese East Indiaman from the 1530s, the heart of the age of discovery, with its cargo of treasure and trade goods intact, having lain untouched and unsuspected in these sands for nearly 500 years.

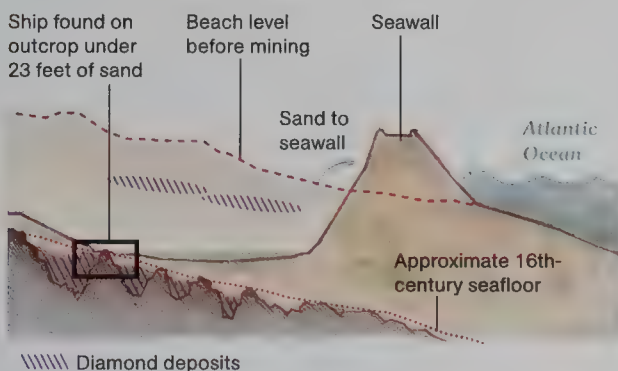
"This is a priceless opportunity," says Francisco Alves, the doyen of Portuguese maritime archaeologists and the head of nautical archaeology under the Ministry of Culture. "We know so little about these great old ships.

Writer Roff Smith lives, and weathers storms, on the coast of England. Photographer Amy Toensing often covers remote outposts for National Geographic. Artist Jon Foster is best known for illustrating works of science fiction and fantasy.



Diamonds are the usual quarry along Namibia's southern coastline. Holding back Atlantic breakers, a 33-foot-tall seawall guards the huge surface-mining operation where the Portuguese wreck was discovered in April 2008. Mining at the site was halted, and archaeologists moved quickly to begin excavations.

Diamond Shipwreck site



NGM MAPS. NG ART. SOURCE: NAMDEB DIAMOND CORPORATION. GRAPHIC NOT TO SCALE

archaeology program at Texas A&M University. Castro has spent more than ten years studying Portuguese trading vessels, or *naus*, lately developing computer models based on the slender archaeological pickings available. “This wreck will give us new insights into everything from hull design, rigging, and how these ships evolved, to little day-to-day things such as how they cooked meals on board and what people brought with them on these great journeys.”

Already, some inspired detective work among the rare manuscripts and royal archives in Lisbon has cobbled together enough bits and pieces to tell the tale of a long-forgotten voyage and a vanished ship that turned out to be as rich in irony and allegory as it was in gold.

The story begins on a fresh spring day in Lisbon—Friday, the seventh of March, 1533, to be exact—when the great *naus* of that year’s India fleet sailed grandly down the Tagus River and out into the broad Atlantic, flags and pennants flying and colorful silks and velvets draped from their towering castles. These were the pride of Portugal, the space shuttles of their day, off on a 15-month odyssey to bring back a fortune in pepper and spices from distant continents. Goa, Cochin, Sofala, Mombasa, Zanzibar, Ternate: Storied places that once had been as remote as the stars were now familiar

This is only the second one ever excavated by archaeologists. All the others were plundered by treasure hunters.”

Treasure hunters are never going to be a problem here, not in the middle of one of the world’s most jealously guarded diamond mines, on a coast whose very name—Sperrgebiet—means “forbidden zone” in German. Far from plundering, officials at De Beers and in the Namibian government, who work the lease as a joint venture called Namdeb, suspended their operations around the wreck site, called in a team of archaeologists, and for a few gloriously diverting weeks mined history instead of diamonds.

It will take scholars years to study the wealth of material gleaned from the Diamond Shipwreck, as it has come to be called. “So much is unknown,” says Filipe Vieira de Castro, the Portuguese-born coordinator of the nautical



ports of call, part of the Portuguese vernacular, thanks to Portuguese ingenuity and cutting-edge technology.

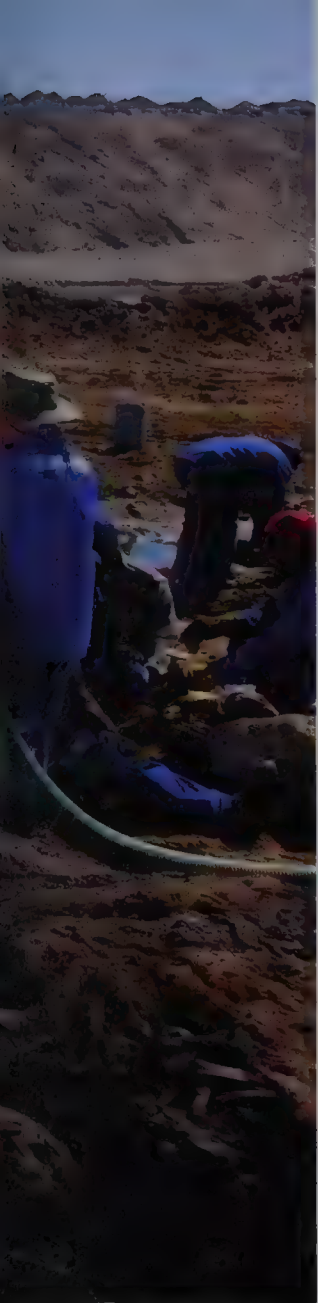
The outbound ships that sailed down the Tagus River in 1533 were sturdy and capable; two of them were brand-new and owned by the king himself. One of these was the *Bom Jesus*—the *Good Jesus*—captained by one Dom Francisco de Noronha and carrying 300 or so sailors, soldiers, merchants, priests, nobles, and slaves.

PINNING A NAME and a story to an anonymous, five-centuries-old shipwreck found unexpectedly on a far-flung shore takes canny sleuthing and more than a little luck—particularly if it is thought likely to have been an early Portuguese wreck. Although the Spanish Empire left mountains of paperwork in its wake, a catastrophic earthquake, tsunami, and fire in November 1755

virtually wiped Lisbon off the map and sent the Casa da Índia, the building that housed the vast majority of precious maps, charts, and shipping records, tumbling into the Tagus River.

“That left a huge hole in our history,” says Alexandre Monteiro, a maritime archaeologist and researcher who works with the Portuguese Ministry of Culture. “With no India archives left to peruse, one has to revert to other, more imaginative ways of finding information.”

In this instance, a vital clue came from the coins found in abundance on the wreck—particularly those beautiful and rare portugueses of King João III. These were minted for only a few years, from 1525 to 1538, after which they were recalled, melted down, and never reissued. Finding so many sparkling new portugueses on the wreck is a strong indication that the ship sailed during this 13-year window in time.



Under constant surveillance, miners and archaeologists salvaged the remains of the ship and its cargo of riches. Hoses vacuumed the diamond-laced sands around the wreck, which was excavated in just ten weeks.

Moreover, the load of copper ingots suggests the ship was on its outward passage to India to buy spices rather than returning.

Although the complete Casa da India records are long gone, some tantalizing snippets remain in libraries and archives that survived the 1755 earthquake. Among these are the *Relações das Armadas*, the so-called narratives of the fleets. A thorough study of the most complete narratives shows that 21 ships were lost on the way to India between 1525 and 1600. Only one of these went down anywhere near Namibia: the *Bom Jesus*, which sailed in 1533 and was “lost on the turn of the Cape of Good Hope.”

Another intriguing pointer to the *Bom Jesus* comes from a letter Monteiro unearthed in the royal archives. Dated February 13, 1533, it reveals that King João had just sent a knight to Seville to pick up 20,000 crusadoes’ worth of

gold from a consortium of businessmen who had invested in the fleet that was about to sail for India—the fleet that included the *Bom Jesus*. Archaeologists had been puzzled by the huge quantity of Spanish coins found among the wreckage—about 70 percent of the gold pieces were excelentes, unexpected for a Portuguese ship. “This letter would go a long way toward explaining that,” says Monteiro. “Spanish investors, it seems, had an unusually large stake in the 1533 fleet.”

A rare 16th-century tome called the *Memória das Armadas* even offers a tantalizing glimpse of the *Bom Jesus*. Issued as a commemorative volume, a sort of Renaissance-era coffee-table book, it contains illustrations of all the fleets that sailed for India each year after Vasco da Gama pioneered the route in 1497. Among the pictures for 1533 is a vignette of two rigged masts under full sail disappearing into the waves and the words “*Bom Jesus*” together with a simple epitaph: *perdido*—lost.

So what did happen? It seems that four months or so after its grand departure from Lisbon, the first fleet of 1533 was struck and scattered by a huge storm. Details are sketchy. An account of the voyage by Captain Dom João Pereira, the fleet’s commander, has been lost. All that remains is a clerk’s acknowledgement that the report was received and a mention that the *Bom Jesus* disappeared in wild weather somewhere off the cape. It is easy to envision what might have happened next: The storm-battered ship was caught up in the powerful winds and currents that surge along the southwest African coast and was driven helplessly northward for hundreds of miles. As the windswept scrub of the Namib Desert hove into view, the doomed nau struck an outcrop of rock about 150 yards from shore. The shuddering blow broke off a big chunk of the stern, spilling tons of copper ingots into the sea and sending the *Bom Jesus* to its grave.

FAST-FORWARD five centuries to a maritime archaeology site that feels slightly surreal. A knot of researchers in hats and sunscreen are excavating a sunken ship that rests some 20 feet below sea level, the Atlantic Ocean held back by a massive earthen retaining wall that leaks a bit along its base. Closed-circuit television cameras, set up around the perimeter of the site, monitor



Mariners' astrolabes (above) helped explorers calculate latitude by measuring the angle of the sun and familiar stars above the horizon—when skies were clear enough for sightings. A five-inch-long syringe (below) would have been used to administer doses of mercury to travelers plagued by syphilis, epidemic in 16th-century Europe.





Money for buying India's precious spices, Spanish and Portuguese coins mingled with Venetian, Florentine, and Moorish (above) in the ship's coffers. The wreck yielded nearly 50 pounds of gold coins. Poignantly simple, a pewter porringer (below) likely served as an everyday eating vessel for one of the ill-fated voyagers.



everyone's movements—a reminder that for all the excitement of the find, this is still a diamond mine. And a rich one, where loose diamonds could well be mingled in the sands the archaeologists are brushing away.

"If it hadn't been for those copper ingots weighing everything down, there would be nothing left here to find," says Bruno Werz, director of the Southern African Institute of Maritime Archaeology, who was called in from Cape Town to assist with the excavation. "Five centuries of storms and waves would have washed everything away."

Werz and a team of researchers have been poring over the wreckage, measuring, photographing, scanning the site millimeter by millimeter with a state-of-the-art, three-dimensional laser scanner. They are trying, among other things, to piece together the ship's final harrowing moments, which would not have been pretty—the mangled remains of the hull and forecastle and a tangle of sails, spars, and rigging sloshing about in the swell, drifting north with the current and probably breaking apart as it went. Mine workers found a huge wooden rigging block three miles farther up the coast.

And what of the people on board, Dom Francisco and the rest?

"A winter storm along this coast is no joke," says Dieter Noli, the mine's resident archaeologist, who has lived and worked along this stretch of the Namib Desert for more than ten years. "It would have been nasty, with winds of over 80 miles an hour and a huge breaking surf. Getting ashore would have been just about impossible. On the other hand, if the storm had blown itself out and the ship wallowed ashore on one of those quiet, fog-shrouded days we also get around here, well, now that opens up all kinds of interesting possibilities."

That may have happened. Although the discovery of human toe bones in a shoe found pinned beneath a mass of timbers indicates that at least one person did not survive, those were the only human remains recovered from the wreck. And few personal possessions were found among the artifacts. These facts lead archaeologists to believe that despite the break-up of the ship along the surf line, many if not most of those aboard made it to land.

And then what? This is one of the most inhospitable places on Earth, an uninhabited

Archaeologist Bruno Werz waits to guide a piece of wooden rigging into a freshwater preservation tank. Such rare treasures promise remarkable new perspectives on Portugal's golden age.



wasteland of sand and scrub stretching for hundreds of miles. It was winter. They were cold and wet, exhausted and bereft. There was no hope of rescue or a search party, for nobody in the outside world knew they were alive, let alone where to start looking. Nor was any ship likely to pass this way by chance; they were far off the trade routes. As for somehow getting back to Portugal—well, the crew might as well have been shipwrecked on Mars.

All the same, things needn't necessarily have ended badly for the castaways, according to Noli. The Orange River lay only 16 miles to the south of the wreck, a source of fresh water whose bloom they might have noticed as they drifted by its mouth. And there was plenty of food about: shellfish, seabird eggs, and loads of desert land snails.

What's more, the Portuguese could have met



the local survival experts. Winter was the season when hunter-gatherers known today as Bushmen ventured north along this shore in hopes of finding the carcasses of the southern right whales that occasionally wash ashore here.

How the Portuguese fared in these encounters would have been up to them, says Noli. "If they had the wit to trade rather than try to take, there is no reason to believe everybody wouldn't get along. The few small bands of hunter-gatherers along the river had no population-resource pressures to contend with, and so no reason to be aggressive to the newcomers. On the contrary, a big, strapping Portuguese dom could well have been seen as an attractive prospect for a son-in-law."

Whatever their final fate, the survivors of the *Bom Jesus* had no inkling of the exquisite irony with which their prayers, uttered so long ago in Lisbon, had been answered. They'd set off on a

great journey in search of riches, pledging altars and icons for favor and success. Now here they were, delivered onto a shore of unimaginable wealth—a 185-mile stretch of desert so fantastically rich in high-quality diamonds that in the early 1900s an explorer named Ernst Reuning made a wager with a companion about the amount of time it would take to fill a tin cup with gems found loose in the sand. The job took all of ten minutes.

For long ages the great river had been washing millions, even billions of diamonds down from deposits as far as 1,700 miles inland. Only the hardest, most brilliant, gem-quality stones, some weighing hundreds of carats, survived the journey. They spilled into the Atlantic at the river's mouth and were washed up the coast, borne by the same cold current that would one day sweep the *Bom Jesus* to its death. □



Sporting helmets since branches can break and fall, an expert crew (top) helps Nick Nichols and Ken Geiger (above) solve a redwood photo riddle.

ON ASSIGNMENT Team Redwood “The world is going to wonder how we got that picture,” says Nick Nichols about the foldout photograph in this month’s issue (a two-by-six-foot fine art print is now available for purchase at PrintsNGS.com). “It was a total team effort.” After a year of talks and planning, photographer Nichols, *National Geographic* Senior Editor Ken Geiger, and several additional team members figured out how to shoot the massive, 1,500-year-old redwood: They tethered a rope between two trees and from it hung a pulley system carrying three cameras. As the cameras descended, Nichols—on the ground nearby—shot pictures remotely from a laptop computer. It took three weeks of predawn attempts, but finally, in one morning, they captured the 84 images that make up the foldout. After the shoot Geiger spent more than 120 hours digitally stitching them together to create what Nichols now lovingly calls “the collaborative composite.”

Society Updates



NG EXHIBITIONS

Tickets are on sale now for “Terra Cotta Warriors: Guardians of China’s First Emperor.” Performance artist Cheng Chi Chang (above) toured Washington, D.C., this spring touting the exhibit, which opens on November 19, 2009, and runs until March 31, 2010, at the National Geographic Museum. Visit warriorsdc.org for exhibition details.

NG CHANNEL

What secrets lie in the past—and future—of the world’s tallest trees? National Geographic Explorer-in-Residence Mike Fay and Humboldt State University’s Steve Sillett find out in *Climbing Redwood Giants*, airing September 29 at 10 p.m. on the National Geographic Channel.

NG FILMS

Former NG All Roads grant recipient Cherien Dabis’s *Amreeka* is the humorous but tender tale of a Palestinian mother’s immigration to the United States. *Amreeka*, a National Geographic Entertainment film, is in theaters now.

GeoPuzzle Answers

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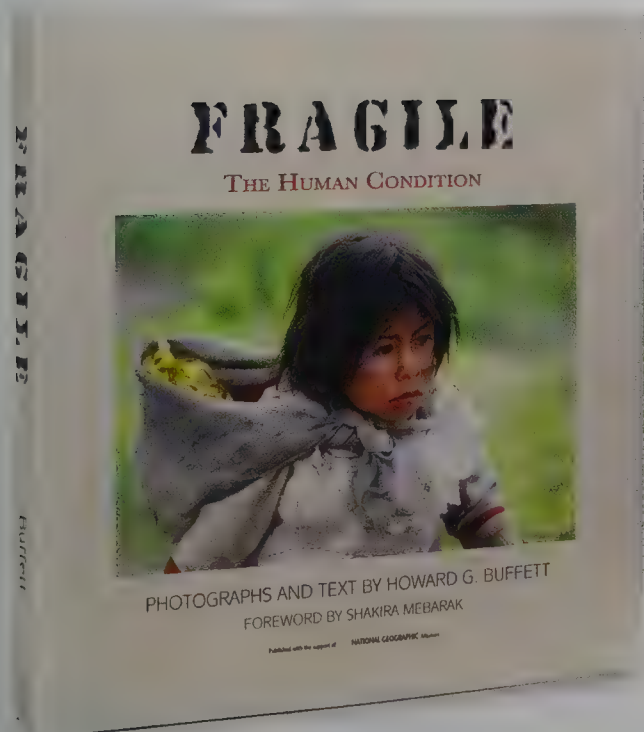
Be the change you want to see in the world.

—MAHATMA GANDHI

FRAGILE: The Human Condition

PHOTOGRAPHS AND TEXT BY HOWARD G. BUFFETT

FOREWORD BY SHAKIRA MEBARAK



Billions of people across this planet live lives of poverty and desperation. They did not choose their circumstances nor can they change them. Their plight is difficult to confront, but impossible to ignore.

The poignant images and personal stories in this book allow us to meet these people, whose resilience and spirit, though fragile, remains uncrushed. Many cling to the hope that their lives will change, and our hope is that this moving portrait will inspire others to find solutions...to be the change.

For more information and to order copies, visit nationalgeographic.com/books



PROCEEDS FROM THE SALE OF THIS BOOK WILL SUPPORT NATIONAL GEOGRAPHIC MISSION PROGRAMS.

320 PAGES • 436 COLOR PHOTOGRAPHS • \$35.00

Amish mantle and miracle invention help home heat bills hit rock bottom

Miracle heaters being given away free with orders for real Amish fireplace mantles to announce the invention that helps slash heat bills, but Amish craftsmen under strain of early Christmas rush force household limit of 2

Save money: only uses about 9¢ electric an hour; so turn down your thermostat and never be cold again

By MARK WOODS
Universal Media Syndicate

(UMS) Everyone hates high heat bills. But we're all sick and tired of simply turning down the thermostat and then being cold.

Well now, the popular HEAT SURGE® miracle heaters are actually being given away free to the general public for the next 7 days starting at precisely 8:00 a.m. today.

The only thing readers have to do is call the National Distribution Hotline before the 7-day deadline with their order for the handmade Amish Fireplace Mantle. Everyone who does is instantly being awarded the miracle heater absolutely free.

This is all happening to announce the HEAT SURGE Roll-n-Glow® Fireplace which actually rolls from room-to-room so you can turn down your thermostat and take the heat with you anywhere. That way, everyone who gets them first can immediately start saving on their heat bills.

Just in time for winter weather, portable Amish encased fireplaces are being delivered directly to the doors of all those who beat the deadline.

These remarkable fireplaces are being called a miracle because they have what's being called the Fireless Flame™ patented technology that gives you the peaceful flicker of a real fire but without any flames, fumes, smells, ashes or mess. Everyone is getting them because they require



GENUINE AMISH MANTLES MADE IN THE USA: Everyone wants to save money on heat bills this winter, so entire Amish communities are working from the crack of dawn to finish. These fine real wood Amish made fireplace mantles are built to last forever. The oak mantle is a real steal at just two hundred ninety-eight dollars because all those who beat the order deadline by calling the National Hotline at 1-866-815-7004 to order the fireplace mantles are actually getting the imported hi-tech Fireless Flame HEAT SURGE miracle heaters for free.

no chimney and no vent. You just plug them in.

The Fireless Flame looks so real it amazes everybody because it has no real fire. So what's the catch? Well, soft spoken Amish craftsmen who take their time hand building the mantles

have a process that forces a strict household limit of 2 to keep up with orders.

"We can barely keep up ever since we started giving heaters away free. With winter just around the corner, everyone's trying to get them. Amish craftsmen are working their fingers to the bone to be sure everyone gets their delivery in time for Christmas," confirms Frederick Miller, National Shipping Director.

"These portable Roll-n-Glow Fireplaces are the latest home decorating sensation. They actually give you a beautifully redecorated room while they quickly heat from wall to wall. It's the best way to dress up every room, stay really warm and slash your heat bills all at the same

time," says Josette Holland, Home Makeover Expert.

And here's the best part. Readers who beat the 7-day order deadline are getting their imported hi-tech miracle heaters free when encased in the Amish built real wood fireplace mantles. The mantles are being handmade in the USA right in the heart of Amish country where they are beautifully hand-rubbed, stained and varnished.

You just can't find custom made Amish mantles like this in the national chain stores. That makes the oak mantle a real steal for just two hundred ninety-eight dollars since the entire cost of the miracle heater is free.

This free giveaway is the best way to slash heating bills and stay warm this



JUST ANNOUNCED: The Heat Surge miracle fireplace has earned the prestigious Good Housekeeping Seal. The product has earned the Seal after evaluation by the Good Housekeeping Research Institute.

HEAT SURGE™ Fireless Flame™

How It Works: The HEAT SURGE miracle heater is a work of engineering genius from the China coast so advanced, you simply plug it into any standard outlet. It uses only about 9¢ of electric an hour on the standard setting. Yet, it produces up to an amazing 5,119 BTU's on the high setting. So watch out, a powerful on board hi-tech heat turbine silently forces hot air out into the room from the vent so you feel the bone soothing heat instantly. It even has certification of Underwriters Laboratories coveted UL listing. It also comes with a limited full year replacement or money back warranty less shipping plus a 30-Day Satisfaction Guarantee. OH and FL resident transactions require the remittance of applicable sales tax. Sorry no shipments to MA residents.



LISTED: E322174



**Hot air only
comes out of
the top vent**

**The hi-tech silent
heat turbine takes
in cold air**

fall and winter. The HEAT SURGE Roll-n-Glow Fireplace gives you zone heating and all the beauty and warmth of a built-in fireplace but rolls from room-to-room so it can also save you a ton of money on heating bills.

Even people in California and Florida are flocking to get them so they may never have to turn on their furnace all winter. And since it uses only about 9 cents of electric

an hour on the standard setting, the potential savings are absolutely incredible.

"We are making sure no one gets left out, but you better hurry because entire communities of Amish craftsmen are straining to keep up with demands. For now, we are staying out of the large national retail stores in order to let readers have two per household just as long as they call before the

deadline," confirms Miller.

It's a really smart decision to get two right now because for only the next 7 days you get both miracle heaters free. That's like putting five hundred bucks right in your pocket and you can save even more money on your monthly heating bills.

"Everyone's calling to get one but those who are getting their Christmas shopping done early are surprising the whole family by

getting two. So when lines are busy keep trying or log onto amishfireplaces.com. We promise to get to every call. Then we can have a delivery truck out to your door right away with your beautiful Heat Surge Roll-n-Glow Fireplace," Miller said.

"You'll instantly feel bone soothing heat in any room. You will never have to be cold again," he said.

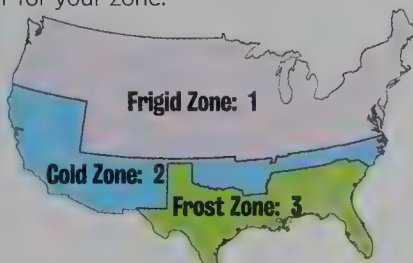
On the worldwide web:
www.amishfireplaces.com

How to get 2 free heaters

The National Toll Free Hotlines are now open. All those who beat the 7-day order deadline to cover the cost of the Amish made Fireplace Mantle and shipping get the HEAT SURGE miracle heater free.

A strict limit of 2 per household has been imposed. Since some home woodworkers want to build their own mantle piece, they are letting people get the imported miracle heater alone for just \$249. Or, with the Amish made mantle you get the miracle heater free.

Use the map below to locate the weather zone you live in and call the Hotline number for your zone.



Claim Code: FP9167

**EVERYONE LIVING IN THE
Frigid Zone: 1
START CALLING AT
8:00 A.M. TODAY
1-866-815-7004**

**EVERYONE LIVING IN THE
Cold Zone: 2
START CALLING AT
8:30 A.M. TODAY
1-866-815-7110**

**EVERYONE LIVING IN THE
Frost Zone: 3
START CALLING AT
9:00 A.M. TODAY
1-866-815-7112**

FOR HEAT SURGE, 8000 FREEDOM AVE., N. CANTON OH 44720

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ON THEIR WAY: Early Christmas orders have turned country roads into pipelines to the big city delivery system. Everybody wants a fireplace that comes fully assembled with a handmade Amish mantle in oak or cherry finish and gets delivered by truck right to your door. All you do is plug it in.

Rolls anywhere to throw an instant heat wave with no chimney, no vents, no wood and no smoke



EASILY ROLLS ANYWHERE: This is the portable Roll-n-Glow® Fireplace that easily rolls from bedroom to living room to keep you warm. No vents, no chimney and no tools. Just plug it in.



SAVES ON BILLS: Everyone can get low bills and stay warm and cozy. The Roll-n-Glow Fireplace saves a ton of money and makes your front room look like a million bucks.



SAFE FLAME: The Fireless Flame looks so real it fools everyone but there is no real fire. That makes the flame window safe to the touch under the watchful eye of a parent. It's where the kids will play and the cat and dog will sleep.



FREE: Get this \$249 miracle heater free. It is being given away free to all who beat the 7-day order deadline for your choice of the oak or cherry finish Amish Mantles. The free heater comes already encased.



Bali Dancer A towering headdress and plug earrings adorn a 1930s Balinese *djanger* dancer, part of a coed performance that was “more of popular fun than of temple dance or disciplined art,” wrote Maynard Owen Williams in his March 1939 *Geographic* article, “Bali and Points East.” The dance’s male participants “at times resemble a troupe of cheer leaders made up like Groucho Marx,” noted Williams. “Syncopated movement, swaying forms, flashing fingers, and glittering crowns in high relief against deep shadows under the banyan tree—such is the *djanger*.” —Margaret G. Zackowitz

🔗 **Flashback Archive** Find all the photos at ngm.com.

PHOTO: ANDRE ROOSEVELT, NATIONAL GEOGRAPHIC STOCK

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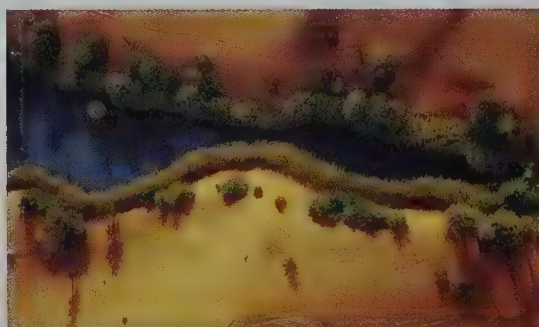
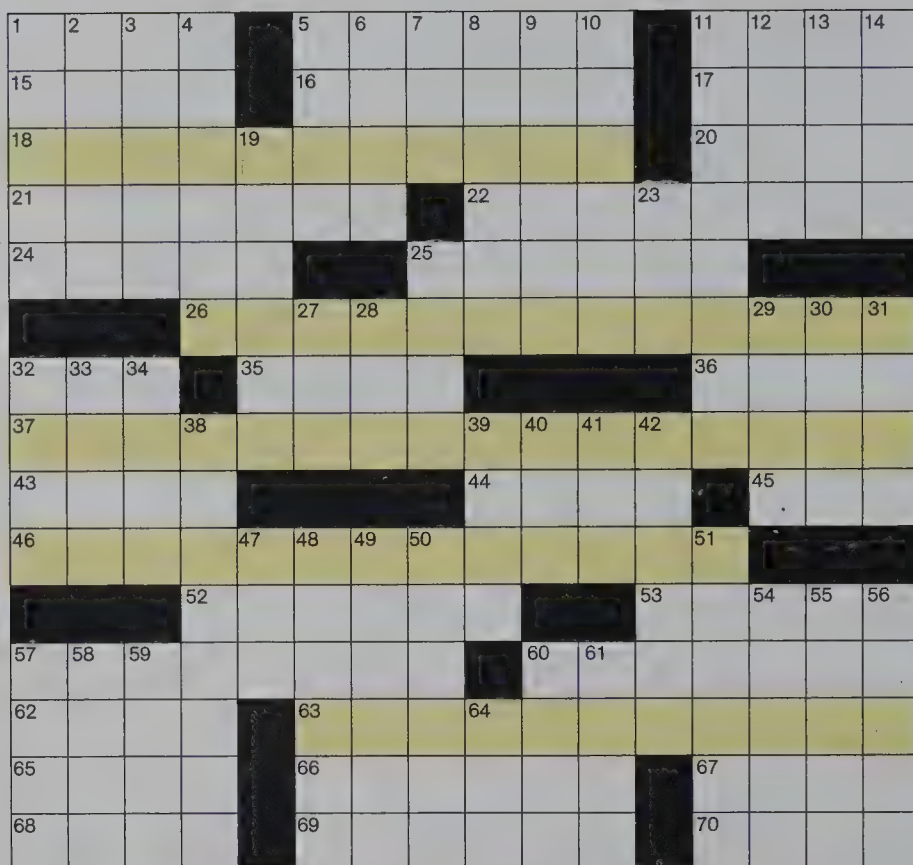


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GEOPUZZLE



Clue Grit

Puzzle by Cathy Allis

We hope your ability to solve GeoPuzzle clues is not drying up like the ancient lakes and rivers that spread across the Sahara thousands of years ago but have long since disappeared (see story, page 100). Tinted clues test your skill at desert crosswordling.

ACROSS

- 1 Inner Hebrides island
- 5 Online scenemaker
- 11 Former Venetian VIP
- 15 Jive talking
- 16 Pinball player's hangout
- 17 Footnote ditto, for short
- 18 Irregular Saharan boundaries?
- 20 Pump part
- 21 Direct a different way
- 22 Option for a blessed delivery
- 24 Edgar Bergen's dummy Mortimer

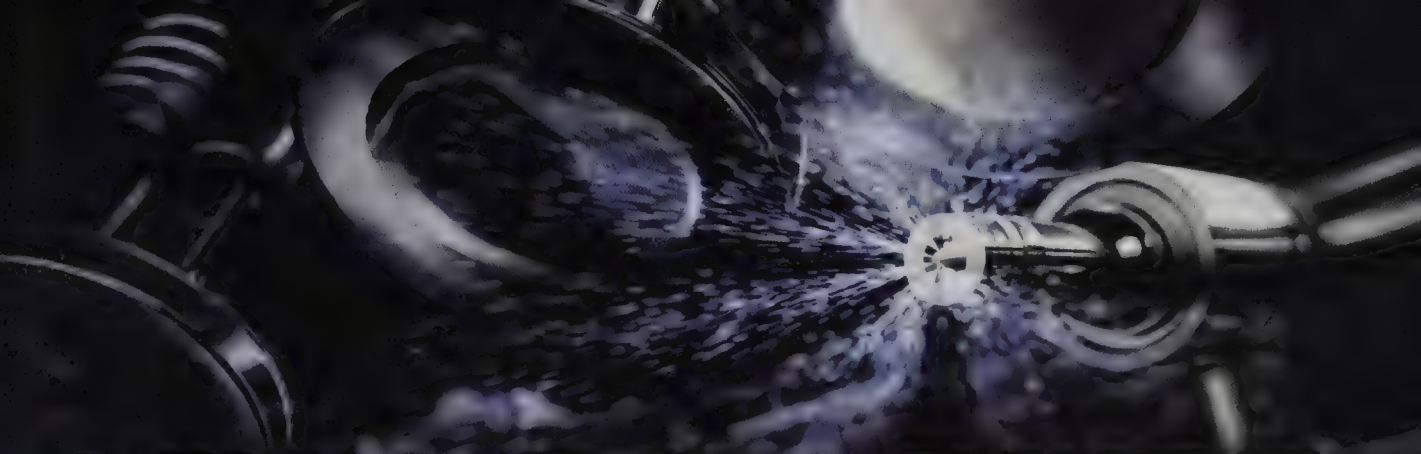
- 25 Crescent-shaped fingernail area
- 26 Nibbled some grains in the Sahara?
- 32 Sahara's cont.
- 35 It may include Saharan camel rides
- 36 Virgil's "conqueror"
- 37 They're helpful for Saharan caravan maintenance?
- 43 Dying words to Brutus
- 44 What some games result in
- 45 Mesabi Range deposit
- 46 Hit some Sahara wear?

- 52 Vortices
- 53 Like Rod Stewart's voice
- 57 Hands-free equipment
- 60 Two-year periods
- 62 Prefix meaning "height"
- 63 Masterful Saharan scams?
- 65 Add to or remove
- 66 Football Hall of Famer Y. A.
- 67 Nobelist novelist Morrison
- 68 Froth
- 69 Dresses down
- 70 On ___ with (equal to)

DOWN

- 1 Stravinsky and Sikorsky
- 2 Of yore
- 3 Kol ___ (Yom Kippur Eve chant)
- 4 Engross
- 5 Freedom from ___ (one of an FDR foursome)
- 6 Our planet, to Planck
- 7 Pre-Christ abbrev.
- 8 Mexican resort city
- 9 Number next to a plus sign
- 10 Botch
- 11 British Prime Minister Benjamin
- 12 It's blown in the winds
- 13 Mojave Desert "monster"
- 14 Temptation location
- 19 Accounting jobs
- 23 Boxer Laila
- 25 Pork product
- 27 Beat ___ pulp
- 28 The Sahara's has no mercy
- 29 Gabrielle Chanel, by nickname
- 30 Always
- 31 Zaire's dictator, Mobutu ___ Seko
- 32 Ice and space, e.g.
- 33 Snapshot, in commercial usage
- 34 College mil. program
- 38 Domains of high-ranking nobles
- 39 Unwelcome freshness
- 40 Its cap. is Addis Ababa
- 41 Ebro or Tajo, *por ejemplo*
- 42 Swerved
- 47 Gp. that spawned the Weathermen
- 48 Experts
- 49 Kind of acid in fertilizers
- 50 Bygone car named for a conquistador
- 51 Holy havens
- 54 Nosy sort
- 55 Feather, in zoology and Latin
- 56 Fatah founder Arafat
- 57 Kaffiyehs, e.g.
- 58 Light tan tone
- 59 Saharan
- 60 Like TV's Kojak
- 61 Murdered consort of Portugal's Pedro I
- 64 The Cards, cut?

**Answers in
Inside Geographic**



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What happened when New Jersey teenagers had to wait a year longer to drive?



MORE OF THEM LIVED TO TALK ABOUT IT.



New Jersey strengthened its Graduated Driver Licensing (GDL) laws and has saved lives. By simply raising its driving age from 16 to 17, not only did New Jersey see a dramatic decrease in teen driving deaths, it became one of the least deadly states for teen drivers.

Allstate believes there's a way to make every turnpike, highway, route and dirt road safer for teens.

SUPPORT THE STANDUP ACT OF 2009

The STANDUP Act* (H.R. 1895) creates a National Graduated Driver Licensing (GDL) law that limits

nighttime driving, reduces in-car distractions, puts a cap on the number of friends in the car and increases the required hours of training and supervision. **When states have implemented comprehensive GDL programs, the number of fatal crashes among 16-year-old drivers has fallen by almost 40%.**

Let's make sure that no matter what state a teen calls home, we can all drive through it safely. Tell your congressional representatives that you support the STANDUP Act of 2009. **Go to allstate.com/STANDUP.**

It's time to make the world a safer place to drive. That's Allstate's Stand.



Allstate
You're in good hands.

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Retirement

*The STANDUP Act is the Safe Teen And Novice Driver Uniform Protection Act of 2009.

Sources: IIHS Wheels Weekly, 2008; Allstate America's Teen Driving Hotspots Study, May 2008; Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System (WISQARS) [Online] (2008). The Cupped Hands logo is a registered service mark and "That's Allstate's Stand" is a service mark of Allstate Insurance Company, Northbrook, IL, Allstate New Jersey Property and Casualty Insurance Company, Bridgewater, NJ. © 2009 Allstate Insurance Company

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NATIONAL GEOGRAPHIC

Egypt's Animal Mummies

PETS OF THE PHARAOHS



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Conversations for a Smarter Planet

A mandate for change is a mandate for smart.

The world is ready for change – that much is clear.

For leaders of all kinds, this moment presents a rare opportunity. Our planet is not just getting smaller and flatter. It is also becoming smarter. And that means we have the potential to change the way the world literally works.

Computational power is now being put into things we wouldn't recognize as computers – cars, appliances, cameras, roadways...even pharmaceuticals and livestock. We are interconnecting all of this through the Internet, which has come of age. And we are applying powerful new systems and sophisticated analytics to turn oceans of data into insight, knowledge and intelligence.

Consider the changes already under way.

Smart traffic systems are helping to reduce gridlock by 20%, cutting pollution and increasing ridership on public transit.

Smart food systems based on RFID technology embedded into supply chains are monitoring meat, poultry and other items from the farm to the super-market shelf.

Smart healthcare systems are helping to lower the cost of therapy by as much as 90%.

Police departments are correlating street-level information from myriad observations and devices to identify crime patterns – helping prevent crime, rather than simply punishing it.

The list is long, and the transformation is just beginning. Its benefits will be reaped not only by large enterprises, but also by mid-sized and small companies – the engines of economic growth everywhere – and by individuals and communities around the world.

Imagine how a smarter planet will transform *all* the things we seek. The ways we pursue economic growth, societal progress, environmental sustainability and cures for disease. The way we interact with each other and with the world.

The opportunity is before us, and the moment will not last forever. Will we seize it? As we look to stimulate our economies and rebuild our infrastructure, will we simply repair what's broken? Or will we prepare for a smarter future?

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CHARLIE HAMILTON JAMES

This kingfisher will smack the minnow in its beak against a branch, then swallow it. The minnow at right leaped to safety. Story on page 76.

NATIONAL GEOGRAPHIC

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More of the big cats live in captivity in the U.S. than in the wilds of Asia.

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Last year acorns were scarce in many places. What's behind the shortfall?

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In Rotterdam, ermine moth larvae instigate a massive cover-up.

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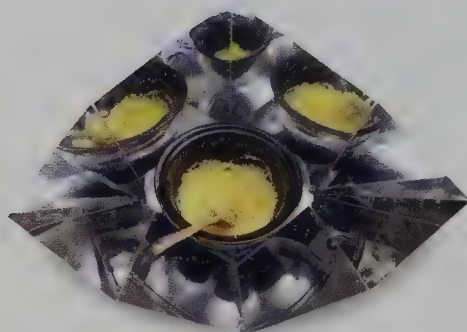
Flashback

GeoPuzzle

On the Cover

Two thousand years ago this Egyptian cat was killed and mummified. A pilgrim probably bought it to offer to a god, along with a prayer.

Photo by Richard Barnes



ngm.com



Last Call for Photos
October 31 is the last day for English-language edition readers to enter the International Photo Contest. Winners earn prizes and a spot in the final competition.

GREG YOPE

TODAY
Thinking green

TOMORROW
Planning for blue



TOYOTA

toyota.com/future

Can today's environmental thinking inspire tomorrow's technology? Toyota believes so. Since its launch, the Prius has earned the love of millions of forward-thinking drivers. We estimate our hybrid technology has saved a billion gallons of gas and lowered CO₂ emissions by billions of pounds*. It's also paving the way for the next generation of environmental vehicles. Like cars charged at home. Or cars that will run solely on electricity, or consume hydrogen and emit only water. Because when it comes to thinking green, the sky's the limit.

*Estimated savings compares each U.S. hybrid vehicle's EPA combined mpg rating with its segment average based on latest EPA Trends Report (driven 15,000 miles annually). Actual mileage will vary. ©2009

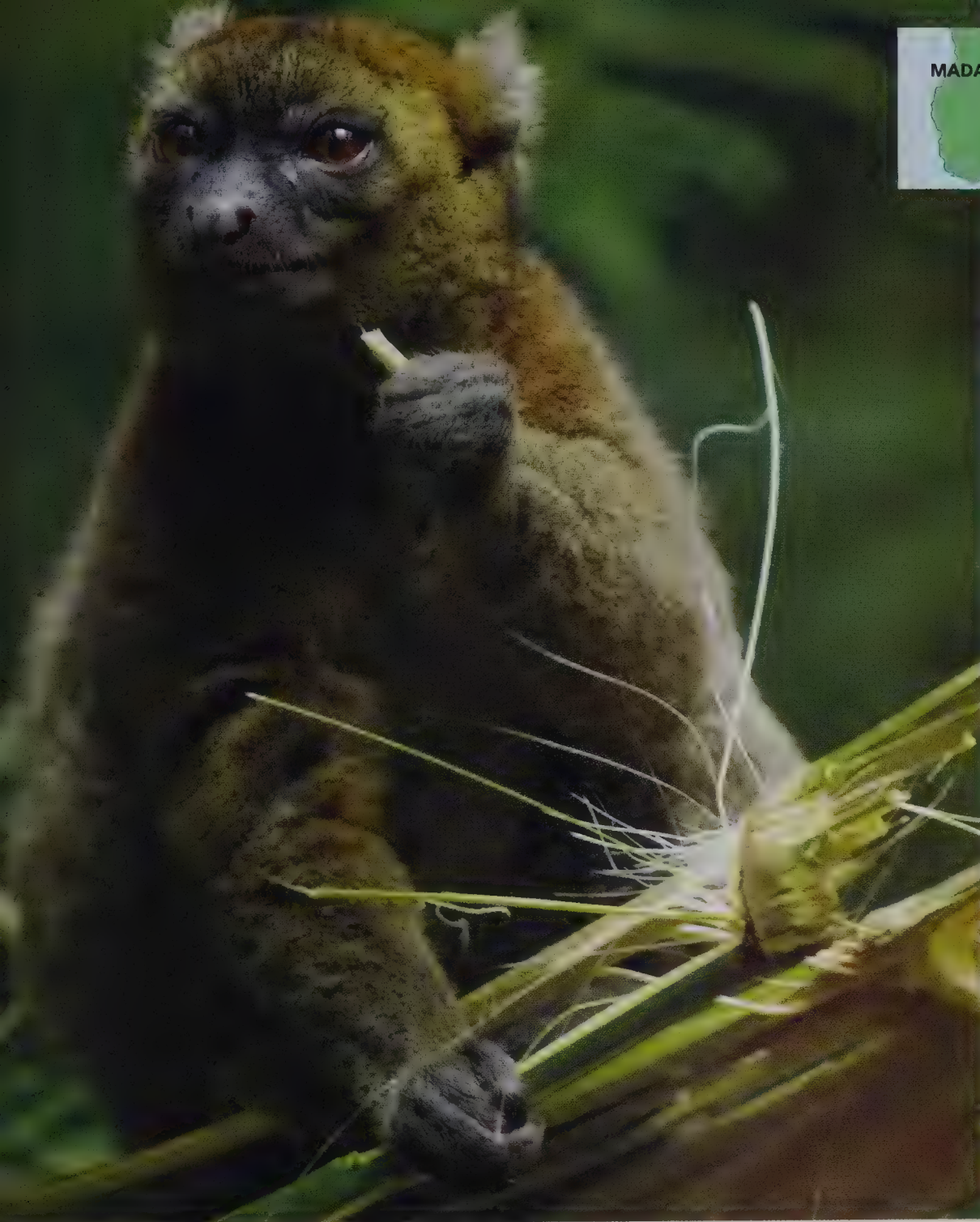


Photographer Stephen Alvarez shoots from a stone spire in Tsingy de Bemaraha national park and reserve.

It happened to Stephen Alvarez, as it does to many photographers. He looked at a few pictures from an exotic landscape, in this case Madagascar, and thought, How hard can it be to photograph that place?

As you'll see from the photographs he made for this month's story "Living on a Razor's Edge," it is hard. Really hard. To begin, it took him five days to trek to Tsingy de Bemaraha national park and reserve from Madagascar's capital, Antananarivo. When he, writer Neil Shea, and a team of scientists reached the area's rugged limestone towers, they had to pick their way along knife-edge ridges that dropped off into 400-foot-deep canyons. "It was like walking on a pile of steak knives," Stephen says. "I had little fear of falling 400 feet. The real fear was falling six inches and slicing my femoral artery."

Because the going was so arduous, the team felt lucky to cover half a mile in a single day. One afternoon Neil tripped over a vine and landed on a sharp spike of limestone that punctured his knee nearly to the bone. It took two painful days for him to reach a nurse who treated the wound. She asked why he would ever want to go to a place like the *tsingy*. The answer is easy. Really easy. It's because the *tsingy* is the kind of exotic, unexplored place *National Geographic* magazine has taken readers to for more than a century.



Greater Bamboo Lemur

(*Prolemur simus*)

Size: Head and body length, 40 - 42 cm (15.7 - 16.5 inches); tail, 45 - 58 cm (17.7 - 22.8 inches)

Weight: 2.2 - 2.5 kg (4.9 - 5.5 lbs)

Habitat: Forest patches with bamboo in the south-central portion of the eastern rainforest of Madagascar

Surviving number: Estimated at fewer than 160

Photographed by Itaki Relanzón

WILDLIFE AS CANON SEES IT

On the menu: bamboo, bamboo and more bamboo. The greater bamboo lemur is one of the few creatures on Earth to depend on a diet of bamboo. It lives in small groups, generally of four to seven, and is active at dawn, dusk and into the night. Populations are highly fragmented, sometimes hundreds of miles apart, as the lemur is found only in those patches of forest where its mainstay meal still grows. These bamboo oases are besieged by

deforestation due to agriculture and logging. What's more, the lemur is regularly hunted for food. Once widespread, this bamboo connoisseur is now one of the world's most endangered primates.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.

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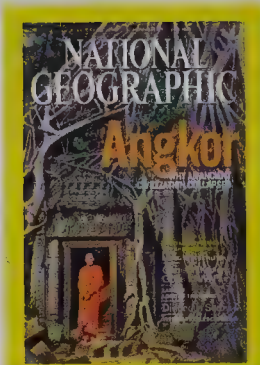
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July 2009

Top Ten State Fair Joys

I enjoyed Garrison Keillor's honest and lively description, but in my 79 years, I have gone only once to a state fair. I found it so noisy, bizarre, weird, and gross that I made it a point never to go again, which explains why I am still sane.

BOB SAXTON
Eugene, Oregon

Being Finnish, I've always found the fascination for "twisted" or "evil" fairs present in the horror-fiction genre to be somewhat baffling, but this piece gave great insight into the phenomenon. It was an interesting glimpse into American culture.

ANTTI VJ NIEMELÄ
Helsinki, Finland

Reading this article, I sadly realized that Garrison Keillor, once a barometric proponent of all that was and is good about Americana, has been reduced to a bitter pessimist. Having myself attended fine state fairs in Iowa, Illinois, Wisconsin, and California, I only hope that Keillor may yet live through his own cathartic *Christmas Carol* night, during which he is visited by the ghosts of state fairs past,

present, and future. He might emerge a new man, coming back to his listeners and readers as the wry and insightful commentator we have long admired—corn dog and cheese-cake on a stick in hand.

DEAN G. LOUMBAS
San Francisco, California

Midwesterners are "abstemious"? Maybe I am foggy on the meaning of that word, but judging from the picture on pages 70-71, it looks to me as if Iowans are eating state fair fare 365 days a year.

KAY TESKE
Virginia Beach, Virginia

What a brilliantly articulated story. I easily slipped into the Midwest summer and lost myself among the corn-dog-chomping crowds. State—or in our case, county—fairs are a wonderful respite from the maddeningly boring and sterile workdays we endure in our "real" lives.

HILARY AMOLINS
Consecon, Ontario

My husband and I met at the San Mateo County Fair in 1946. What fond memories we still have. Every part of that magical place still holds us after 61 years of marriage. No one we talk to understands, since present-day state fairs are not at all the same. In 1946, fairs were a social occasion. The carnival portion was a small part. The exhibits and entertainment were unforgettable.

MINA PRATT
Oakhurst, California

Your article reminded me of an experience I had at the Washington County Fair in New York a few years ago.

I happened upon a girl—she could not have been more than eight—washing her sheep in preparation for a later showing. She didn't see me. When the animal was well sudsed up, she paused, went to the sheep's head, and said softly, "Even if we don't win, I want you to know that you are the most beautiful sheep here." It seems to me that when you get through the rides, the foods, and the carnival atmosphere, what stands out about state fairs is the purity of values in our young people's fair exhibits. Incidentally, her sheep came in second, but it really didn't matter. The animal already knew how beautiful it was.

IRV WEST
Thurman, New York

The Serbs: One Nation Divisible

Even the subtitle of this story seems to mock the sad fate of the Serbs—carved up between several countries, disinherited, and disenfranchised.

NEBOJSA MALIC
Arlington, Virginia

Your article states that the Battle of Kosovo lived on in Serbian literature and song as a symbol of the struggle against foreign domination. I am reminded of an old adage: "It's better to die on your feet than to live on your knees."

EVAN DALE SANTOS
Adelanto, California

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All those "green steps" got us to thinking: Imagine what SunChips and National Geographic could do together to help people start their own personal Green Effect? What would they create, change, or reinvent?

To get the Green Effect movement started, we decided to award \$20,000 each to five people or groups—such as a school, scout troop, green

club, parents' organization, or church committee—with the most compelling, actionable ideas for green change.

The Green Effect challenge was on, and the response was incredible! In six weeks we received over 2,500 entries—each a great, green idea! More than 10,000 of your online votes determined one winner, and a panel of judges—each chosen for their involvement in the green community—picked the other four. Each winner received the funding to bring their idea to life. In addition, the five winners traveled to Washington, DC, to celebrate and share their projects with environmental leaders at National Geographic Society headquarters.

Turn the page and discover the small, imaginative steps people across the country are taking to create big change for our planet. You can learn more about the winners and see their videos at greeneffect.com—you just might even be inspired to create your own Green Effect.



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All We Are Saying...Is Give Plants a Chance!

Hingham High School

HINGHAM, MA

Hingham High School (HHS) wants to teach its children how plants and produce fit into a green lifestyle. HHS will use its award money to positively change the surrounding community and the environment. The greenhouse at HHS will give students the skills and knowledge to create "green" gardens, grow organic fruits and vegetables, prepare meals using their own produce—and appreciate the value of eating locally grown

produce to reduce their carbon footprint and improve food quality. Their greenhouse will also be used for a student-run composting program and for growing and studying endangered local plant species. Beyond the impact on the 1,000+ student body, faculty, and community, every year's senior class would graduate with an "A" in appreciation for a green lifestyle, and the skills necessary to translate their green aspirations into attainable goals.

Growing Your Own Green Effect

"Big change starts with small steps" is the SunChips philosophy. And as you can see by the winners of the Green Effect, there is no shortage of people with great green ideas for making change happen. Let these winners inspire you so that the Green Effect spreads, and we all help to make the planet greener, better...happier. The next step is yours.

OUR JUDGES:



JAYNI CHASE

Founder, Center For Environmental Education, eco-savvy mother of three, and wife of Chevy Chase



PHAEDRA ELLIS-LAMKINS

Chief Executive Officer, Green For All



DAVE HAFT

Group Vice President, Sustainability and Productivity, SunChips®/Frito-Lay



BOYD MATSON

Host, National Geographic Weekend, journalist



EDWARD NORTON

Actor, social and environmental activist



The reason so many Serbs feel vilified is evident from the way the Srebrenica massacre is still portrayed in the media. It has been 14 years since that event. The perpetrators have been largely identified and named. Their guilt is individual, and they are bearing the consequences. Modern society rejects the concept of collective guilt. To use language that implies that all ethnic Serbs are somehow responsible for the events in that Bosnian town a decade and a half ago is akin to blaming all Germans, past and present, for Auschwitz. Yet this behavior persists. It is doubtful that the majority of ethnic Serbs ever supported any such thing as the project of Greater Serbia. Furthermore, there is no implication that even those who did support such an idea supported ethnic cleansing, let alone participated in it.

STANISLAV STANKOVIC
Tampere, Finland

Divining Angkor

It always amazes me when I witness yet another beautiful wonder-of-the-world ruin. How were the rulers of these ancient civilizations able to get away with creating monuments to their gods, mortal coils, and palatial amusements while neglecting the basic needs of their people? Granted, Angkor created wealth with its elaborate system of water storage and distribution, but how many gods and goddesses must be depicted on their shrines and tombs at the expense of building a better infrastructure? The pyramids, Maya temples, churches of all faiths, and palaces of exquisite beauty serve only a fraction of the population, while most people

must either labor or pay for the excesses of the priests, kings, and generals. Give us elaborate universities, hospitals, and museums instead of monuments and shrines to allay our fears of death.

MICHAEL STURDY
Armstrong, British Columbia

How were the rulers of these ancient civilizations able to get away with creating monuments to their gods, mortal coils, and palatial amusements while neglecting the basic needs of their people?

Among the guesses as to why Angkor's civilization collapsed, you mention "rapacious invaders, a religious change of heart, and a shift to maritime trade that condemned an inland city." You seem to think that a reasonable explanation is climatic change that caused the engineering works and dams to fail. An appropriate parallel is made with almost contemporary civilizations in Mesoamerica, which also failed because of changing patterns in the weather. May I suggest an additional idea? Growth and decadence are natural phenomena in history. Phases of growth in a civilization are always linked to high birthrates. Phases of low birthrates always anticipate decadence, lower economic standards of life,

and loss of scientific knowledge. Natural high and low birthrates may help us understand history. This may even shed light on the situation of the world today.

ANGELO BERTOLO
Fiume Veneto, Italy

The hypothesis that the Khmer city of Angkor was abandoned at the end of a megadrought does not explain why the city was not repopulated after the end of the drought. Another possibility is that the Angkor water-management system provided an ideal habitat for the buildup of aquatic snail populations. These snails are intermediate hosts to many parasites, which might have built up to deadly concentrations for those who drank or entered the water. Since Angkor was a religious site and water was considered sacred, if the water turned deadly, it would be a sign of punishment from the deities in charge. Such a development could cause the religious system to crumble and create a taboo, in turn causing abandonment and preventing repopulation.

WALTER B. SIKORA
Athens, Georgia

In perusing the article on Angkor and its demise, I was struck by the phrase: "When populations in countries exceed the carrying capacity of the land, real trouble begins." I see a similarity to our worldwide condition at present: Overpopulation, war, and the lack of food worldwide are approaching a climax, and we as a world community are blind to what we are doing.

DON BAILEY
Rigby, Idaho

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LETTERS

In the early 1960s my parents went on a Pan Am around-the-world trip. The one sight my father could not forget was Angkor Wat. For years he wondered what happened to those beautiful ruins. He died without learning the answer. Now, ten years after his death, I picked up your July issue and finally learned the answer to his question.

BENJAMIN H. WEST
Galena, Ohio

Though I long to go to Angkor, insufficient finances, age (74 years), and health are deterrents. This article with its beautiful photographs has shown me around the place for free.

But there is one omission: You ignore India's contribution to the restoration of the monuments.

M. R. RAJAGOPALAN
Tamil Nadu, India

Cosmic Vision

The article's opening page mentions that telescopes "will carry the eye to the edge of the universe." There is no edge to the universe. As long as people believe there is an edge, we'll waste money looking for it and continue letting people here on Earth starve.

ROBERT DAUBENSPECK
White River Junction, Vermont

Your article states the big bang was noisy! When did it go from

theory to fact? I believe the world was created by God—and I looked at your pictures and said, "What a great creation."

EARL WARD
Bathurst, New Brunswick

Geography: Spread of the Amish

If you want to understand the spread of the Amish better, try driving a horse or pulling farm equipment through bumper-to-bumper traffic where 50 years ago grass grew in the middle of the road. My uncle grew up in Lancaster County, Pennsylvania, not more than 20 miles from where his ancestors settled in the early 1700s. He now has children in five states because

of urban-sprawl-driven farmland prices and road congestion.

RUFUS BURKHOLDER
Fleetwood, Pennsylvania

On the "Spread of the Amish" map, I was surprised to find a dot on the north shore of Lake Huron—a new Amish community very close to our home. As I write this letter, hammers are pounding on the hill below our house, where an Amish family is building. When we retired here two years ago, we persuaded the seller to sever the house and woodlot from the farmland. He sold the unimproved land to our delightful Amish neighbors.

MARGARET HIBBARD
Iron Bridge, Ontario

Your article states that the Amish religion emphasizes

"separation from the world." I am not Amish, but an Amish person explained to me that their philosophy is not about separation from the outside so much as community from within. Their denial of modern technology is based on the belief that automobiles and television draw individuals away from community and family.

JESSICA GOLDRING
Great Neck, New York

Technology: The Eyes Have It

You have an article on eye-glasses adjusted by pumping fluid between two lenses. About 50 years ago I read this exact idea in a science fiction novel. Now it has come to fruition.

BOB PATRICK
Everton, Arkansas

Flashback: Eyes on the Pies

The story on Automats brought back memories of childhood trips to that magical place. Imagine a secret little door that you put money in. You turn a knob, and out comes lunch. And before you leave, make yet one more trip to buy dessert. You had to sit at a table of strangers. We survived, we enjoyed, and now we remember those days of years ago.

RONALD REGEN
Rockaway, New Jersey

GeoPuzzle

You've marvelously combined my two top interests: geography and puzzles. I look forward to a GeoPuzzle in every issue.

MARC HERBERT
Walnut Creek, California

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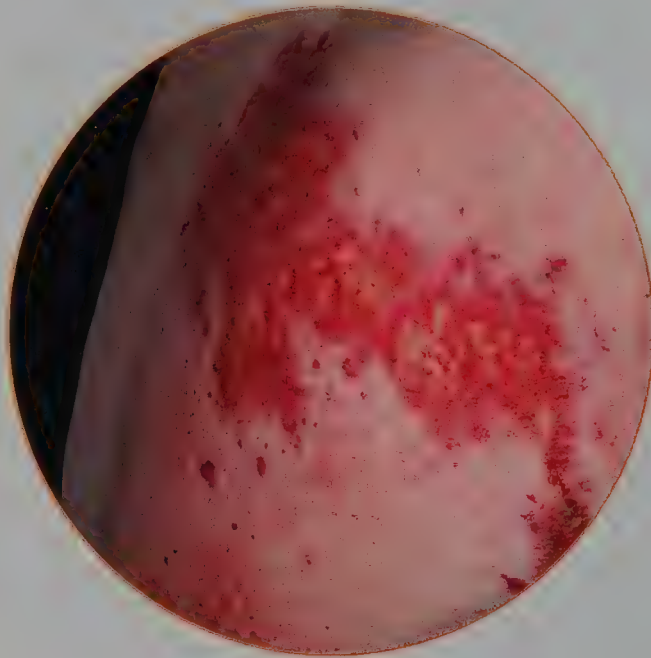
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IF YOU HAD CHICKENPOX AS A CHILD, YOU COULD GET SHINGLES NOW.

The chickenpox virus is still in your body.

It can resurface as Shingles, a painful, blistering rash. The Shingles rash usually lasts up to 30 days, and for most the pain lessens as the rash heals. But some people who develop Shingles experience long-term pain that can last for months, even years.

ZOSTAVAX is a vaccine that can help prevent Shingles.

ZOSTAVAX is used to prevent Shingles in adults 60 years of age or older. Once you reach age 60, the sooner you get vaccinated, the better your chances of protecting yourself from Shingles. ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it. Talk to your health care professional to see if ZOSTAVAX is right for you.

Important Safety Information

ZOSTAVAX may not fully protect everyone who gets the vaccine. You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin and neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. Possible side effects include redness, pain, itching, swelling, warmth, or bruising at the injection site, as well as headache. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088. Before getting vaccinated, talk to your health care professional about situations you may need to avoid after getting ZOSTAVAX. Please see the Patient Product Information on the adjacent page.

Before you get **Shingles**, ask about ZOSTAVAX.

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**Patient Information about
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Generic name: Zoster Vaccine Live

You should read this summary of information about ZOSTAVAX¹ before you are vaccinated. If you have any questions about ZOSTAVAX after reading this leaflet, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 60 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles. If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people.

ZOSTAVAX may not protect everyone who gets the vaccine. ZOSTAVAX cannot be used to treat shingles once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including nonprescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, warmth, or bruising where the shot was given.
- headache.

The following additional side effects have been reported in general use with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- fever
- hives at the injection site
- joint pain
- muscle pain
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

What else should I know about ZOSTAVAX?

Vaccinees and their health care providers are encouraged to call (800) 986-8999 to report any exposure to ZOSTAVAX during pregnancy.

This leaflet summarizes important information about ZOSTAVAX.

If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

Rx only

Issued April 2009

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Warren Buffett and the Gecko. They go together like pie and chips. And since Mr. Buffett's Berkshire Hathaway Inc. acquired GEICO in 1996, the two have seen GEICO grow to become the third-largest personal auto insurer in the nation. Of course, GEICO has a long history of helping people save money on their car insurance. Little wonder why S&P has consistently awarded GEICO a AAA rating for financial strength — its highest grade. Mr. Buffett would say it's that legacy of great service that helped over 3 million drivers switch to GEICO last year. Of course, a hardworking gecko might've helped a bit too.

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Some discounts, coverages, payment plans, and features are not available in all states or in all GEICO companies. GEICO auto insurance is not available in Mass. On December 31, 2007 Government Employees Insurance Company had admitted assets of \$12.9 billion, and policyholder surplus of \$5.1 billion (including \$33.4 million in paid up capital stock). Total liabilities were \$7.8 billion, including \$7.1 billion in reserves. Additional financial information is available at: <http://www.geico.com/about/corporate/financial-information/>. GEICO (Government Employees Insurance Company) is the third-largest private passenger auto insurer in the United States based on the latest 12-month written premium through June 2008. • Government Employees Insurance Co. • GEICO General Insurance Co. • GEICO Indemnity Co. • GEICO Casualty Co. GEICO: Washington, DC 20076. GEICO Gecko image © 1999 - 2009. © 2009 GEICO

Water Worlds A droplet framing a fish, a river teeming with people—water is the key to all life. It's also a building block for some great pictures. So take your best shot of the wet stuff, or document some different element, then send it our way. Every month this page features two photographs: one chosen by our editors, one chosen by our readers via online voting. For guidelines, a submission form, and more information, go to ngm.com/yourshot.



EDITORS' CHOICE

Debasis Roy Asansol, India

While transferring fish from one bowl to another, science tutor Roy, 27, was inspired. He composed this scene—a baby guppy sustained by a single droplet, cradled on a grass leaf atop a wooden stool—then put the fish back.

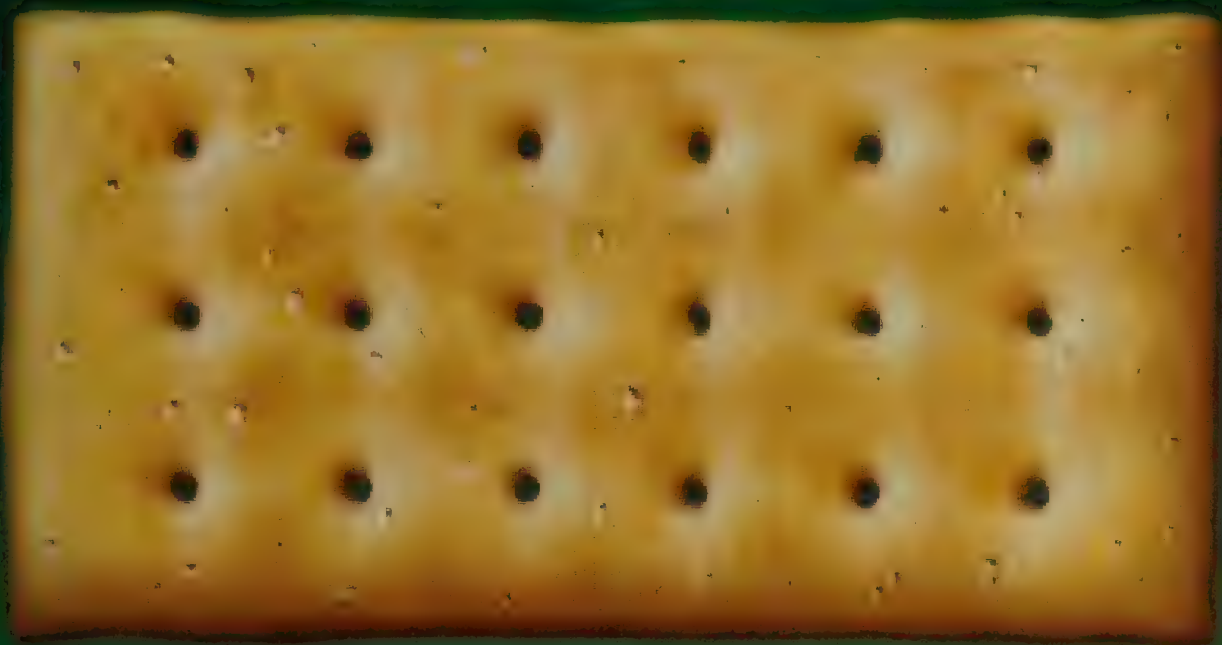
Alankar Chandra New Delhi, India

On his way to take a predawn bath in the holy city of Haridwar, Chandra, a 25-year-old business-school graduate, climbed a footbridge and captured a timeless sight: Hindu pilgrims spiritually purifying themselves in the sacred waters of the Ganges.



READERS' CHOICE

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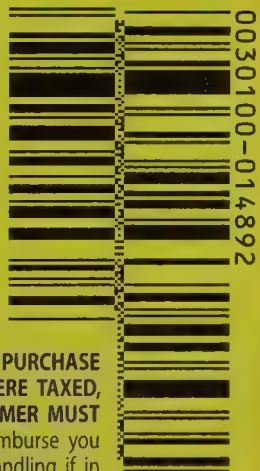


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A cracker that melts in your mouth? **Now that's rich.**



The Crasher

Melissa and Jackson Brandts (inset below) of Watertown, Minnesota, just wanted a memento of their trip to Canada's Banff National Park. Then a curious little creature changed everything. A ground squirrel scampering across the rocks was intrigued by their clicking camera and stopped to investigate. Jackson snapped



a picture using the remote. After Melissa submitted the photo to Your Shot, it was chosen as one of our Daily Dozen favorites, posted on the *Geographic* website—and a furry star was born. The ground squirrel picture went viral on the Internet almost overnight. Pranksters digitally removed the animal from the lakeside and dropped it into famous photographs:

The creature crashed scenes from the Beatles' *Sgt. Pepper* album portrait to an Apollo moonscape and taunted notables, including Tiger Woods and Abraham Lincoln. The Brandts also achieved their own celebrity, telling their story on television and to newspapers around the world. Will your vacation photo be the next big Internet sensation? Send it to us at ngm.com/yourshot and find out. —Margaret G. Zackowitz



Scene Stealer When they fired their camera's remote to get this ground squirrel in the picture, its autofocus function consigned Melissa and Jackson Brandts to a blurry background. **Turn the page for more animal images.** ►►

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LONG

Sanjay Upadhyay

Bangalore, India

Ashes the chimpanzee was born fuzzy but later lost all his hair. Visiting the Mysore Zoo, Upadhyay came across the naked animal. "He was sitting alone and looked sad," recalls Upadhyay, who works for a software company.

Andrew Wilson

Fall River, Massachusetts

A deer at the Buttonwood Park Zoo in New Bedford, Massachusetts, was untroubled that the leafy branch it was munching had flipped up to cover its eyes. Says Wilson, a Fall River city employee, "In a matter of minutes the leaves were consumed."



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Sharon Fullingim Socorro, New Mexico

She'd seen the mantis by the hummingbird feeders before, but Fullingim, a sculptor, says she "didn't quite believe it would ever score lunch." The dry husk of the bird's body lay discarded beneath the feeder the next morning—and the bug was back at its perch, waiting for more.

ED VIESTURS

High-altitude mountaineer

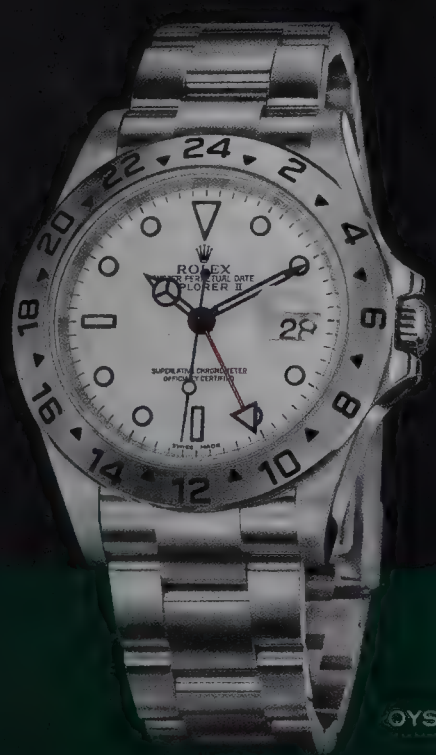
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Betty Berard Broussard

Coteau Holmes, Louisiana

The sky suddenly darkened and the rain came pouring down as Broussard, a retired state worker, photographed this owl near her home. "I hurriedly lifted the flash and took this photo," she remembers. The flash filled the owl's eyes with light in the gloom.

Morgan Ball

Lompoc, California

One damp night, says Ball, a biologist at Vandenberg Air Force Base, "I came across this little guy sitting right on the centerline." A friend drove his car to position the headlights behind the hopper, and Ball shot "from a toad's-eye view."



Welcome to Kendall

FROM THE BEST LAND COME



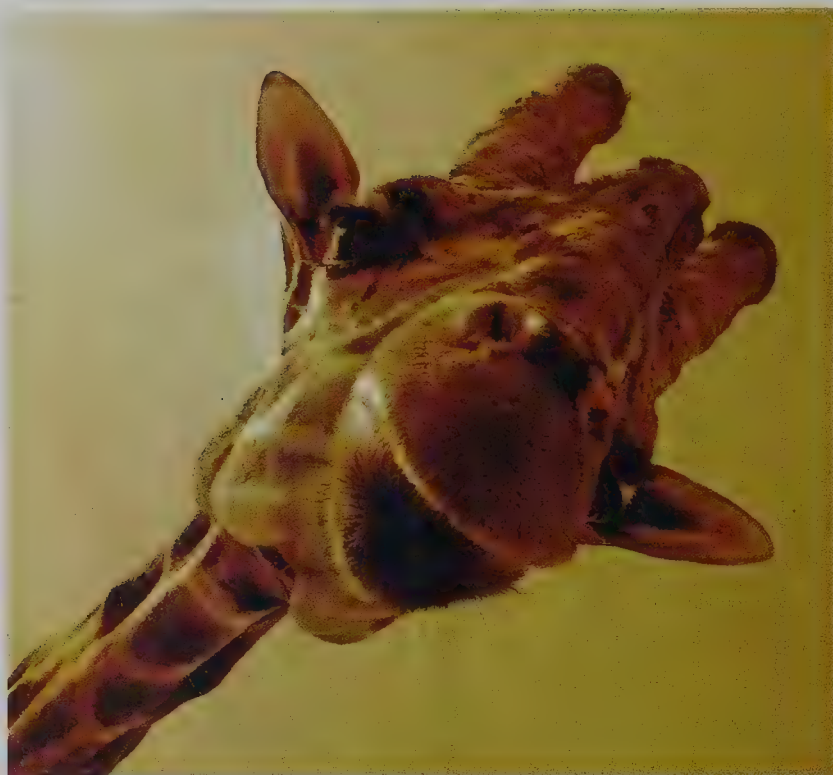
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THE BEST WINE

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Erin Brotherton

Livonia, Michigan

Her car's sunroof was all that came between stay-at-home mom Brotherton and a carrot-seeking giraffe during a trip to an Ohio wildlife park.

Peter G. Allinson

Kingsville, Maryland

Andrew Armour, owner of a whale-watching business, swam with this young sperm whale off the coast of Dominica. The whale is so tame he comes when called, notes Allinson, a doctor who counts diving medicine among his specialties.





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A proud *forcado* is bloodied but unbowed after a bullfight in Évora, Portugal.

More of Carlos
Cazalis's work can be
found at cazalis.org.

Brotherhood of the Bull Portuguese bullfighters belong to a unique tradition. For one thing, the bulls aren't killed in the ring. For another, some participants, called *forcados*, are amateurs. They're locals with day jobs, neighbors who cement their friendship in an ancient way: by risking their lives together. Their event is the *pega*. Eight men enter an arena, line up in single file, then try to subdue a charging bull by hand. They have no weapons, only each other to rely on. Every emotion is on naked display. There's something timeless about their bravery, something unifying about the beast. These bind them to antiquity and virility. Perhaps they're true descendants of the bull-vaulting Minoans. Certainly their way—their honor in the ring, their deeply cultivated sense of family outside it—is what I'd long been seeking.

Bullfighting is in my blood, but connecting with it, personally and artistically, has been a lifelong trial. I was born in Mexico, where my grandfather ran a plaza and my great-uncle was "El Calesero," a legendary matador. For years I photographed the sport professionally, but I couldn't see past the celebrity and corruption, or find any hidden authenticity. In 2003 I moved to Spain, hoping to shoot a series of intimate portraits of those involved in this controversial ritual. But it wasn't to be. Spanish matadors are cloaked in ego and machismo; they show little emotion. I began to wonder if my quest was quixotic. Then I learned of the *forcados* in Évora, Portugal. I've followed them for four years, and they're the real thing.



You'll never forget that day.

PLAVIX can help keep you from going through it again.



PLAVIX can help save lives for those who've had a heart attack caused by a completely blocked artery.

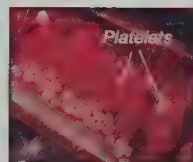
Without PLAVIX



Clots that block off arteries are the main cause of heart attack. And now that you've had a heart attack you are at a greater risk of having another that can be fatal. That's why your doctor may put you on PLAVIX, along with your

other heart medicines. Taking PLAVIX with your other heart medicines goes beyond what other heart medicines alone can do to keep blood platelets from sticking together and forming dangerous clots.

With PLAVIX



Important Safety Information: If you have a stomach ulcer or other condition that causes bleeding you should not use PLAVIX. Taking PLAVIX alone or with some other medicines including aspirin may increase bleeding risk. Tell your doctor before planning surgery or taking aspirin or other medicines with PLAVIX, especially if you've had a stroke. Some medicines that are used to treat heartburn or stomach ulcers, like Prilosec, may affect how PLAVIX works, so tell your doctor if you are taking other medicines. If fever, unexplained weakness or confusion develops, tell your doctor promptly. These may be signs of TTP, a rare but potentially life-threatening condition, reported sometimes less than 2 weeks after starting PLAVIX. Other rare but serious side effects may occur.

Ask your doctor how PLAVIX can help increase your protection against future heart attack, stroke, and even death.

To learn more about heart attacks and PLAVIX, visit www.plavix.com or call 1-877-920-1464.

You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch, or call 1-800-FDA-1088.

See important product information on the following pages.

If you need help paying for prescription medicines, you may be eligible for assistance. Call 1-888-4PPA-NOW (1-888-477-2669), or go to www.pparx.org



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WHO IS PLAVIX FOR?

PLAVIX is a prescription-only medicine that helps keep blood platelets from sticking together and forming clots.

PLAVIX is for patients who have:

- had a recent heart attack.
- had a recent stroke.
- poor circulation in their legs (Peripheral Artery Disease).

PLAVIX in combination with aspirin is for patients hospitalized with:

- heart-related chest pain (unstable angina).
- heart attack.

Doctors may refer to these conditions as ACS (Acute Coronary Syndrome).

Clots can become dangerous when they form inside your arteries. These clots form when blood platelets stick together, forming a blockage within your arteries, restricting blood flow to your heart or brain, causing a heart attack or stroke.

WHO SHOULD NOT TAKE PLAVIX?

You should NOT take PLAVIX if you:

- are allergic to clopidogrel (the active ingredient in PLAVIX).
- have a stomach ulcer
- have another condition that causes bleeding.
- are pregnant or may become pregnant.
- are breast feeding.

WHAT SHOULD I TELL MY DOCTOR BEFORE TAKING PLAVIX?

Before taking PLAVIX, tell your doctor if you're pregnant or are breast feeding or have any of the following:

- gastrointestinal ulcer
- stomach ulcer(s)
- liver problems
- kidney problems
- a history of bleeding conditions

WHAT IMPORTANT INFORMATION SHOULD I KNOW ABOUT PLAVIX?

TTP: A very serious blood condition called TTP (Thrombotic Thrombocytopenic Purpura) has been rarely reported in people taking PLAVIX. TTP is a potentially life-threatening condition that involves low blood platelet and red blood cell levels, and requires urgent referral to a specialist for prompt treatment once a diagnosis is suspected. Warning signs of TTP may include fever, unexplained confusion or weakness (due to a low blood count, what doctors call anemia). To make an accurate diagnosis, your doctor will need to order blood tests. TTP has been reported rarely, sometimes in less than 2 weeks after starting therapy.

Gastrointestinal Bleeding: There is a potential risk of gastrointestinal (stomach and intestine) bleeding when taking PLAVIX. PLAVIX should be used with caution in patients who have lesions that may bleed (such as ulcers), along with patients who take drugs that cause such lesions.

Bleeding: You may bleed more easily and it may take you longer than usual to stop bleeding when you take PLAVIX alone or in combination with aspirin. Report any unusual bleeding to your doctor.

Geriatrics: When taking aspirin with PLAVIX the risk of serious bleeding increases with age in patients 65 and over.

Stroke Patients: If you have had a recent TI (also known as a mini-stroke) or stroke taking

aspirin with PLAVIX has not been shown to be more effective than taking PLAVIX alone, but taking aspirin with PLAVIX has been shown to increase the risk of bleeding compared to taking PLAVIX alone.

Surgery: Inform doctors and dentists well in advance of any surgery that you are taking PLAVIX so they can help you decide whether or not to discontinue your PLAVIX treatment prior to surgery.

Genetics: People with a specific genetic makeup may get less protection against future cardiovascular events, such as a heart attack or stroke, with Plavix.

WHAT SHOULD I KNOW ABOUT TAKING OTHER MEDICINES WITH PLAVIX?

You should only take aspirin with PLAVIX when directed to do so by your doctor. Certain other medicines should not be taken with PLAVIX. Be sure to tell your doctor about all of your current medications, especially if you are taking the following:

- aspirin
- nonsteroidal anti-inflammatory drugs (NSAIDs)
- warfarin
- heparin
- heartburn or stomach ulcer medicines, like Prilosec

Be sure to tell your doctor if you are taking PLAVIX before starting any new medication.

WHAT ARE THE COMMON SIDE EFFECTS OF PLAVIX?

The most common side effects of PLAVIX include gastrointestinal events (bleeding, abdominal pain, indigestion, diarrhea, and nausea) and rash. This is not a complete list of side effects associated with PLAVIX. Ask your doctor or pharmacist for a complete list.

HOW SHOULD I TAKE PLAVIX?

Only take PLAVIX exactly as prescribed by your doctor. Do not change your dose or stop taking PLAVIX without talking to your doctor first.

PLAVIX should be taken around the same time every day, and it can be taken with or without food. If you miss a day, do not double up on your medication. Just continue your usual dose. If you have any questions about taking your medications, please consult your doctor.

OVERDOSAGE

As with any prescription medicine, it is possible to overdose on PLAVIX. If you think you may have overdosed, immediately call your doctor or Poison Control Center, or go to the nearest emergency room.

FOR MORE INFORMATION

For more information on PLAVIX, call 1-800-633-1610 or visit www.PLAVIX.com. Neither of these resources, nor the information contained here, can take the place of talking to your doctor. Only your doctor knows the specifics of your condition and how PLAVIX fits into your overall therapy. It is therefore important to maintain an ongoing dialogue with your doctor concerning your condition and your treatment.

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CLO-BSCW-NGW-JUL09 Revised: July 2009

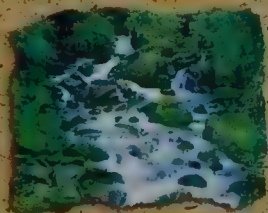


The next generation of forcados stares down a future foe in a Montemor-o-Novo ring. Each year features two Youth Days, one in this municipality, the other in Vila Franca de Xira. At both, group elders acquaint teens and preteens with cows and their ways. An early interest, aficionados say, is often predictive of a forcado-to-be.



At a house near Alcácer do Sal, forcados wrap themselves in traditional red sashes. The 40 men will share a light meal, then a culling process as the group leader, called the *cabo*, selects 16 for the night's match. Later, at the ring, he'll pick eight of those to face a bull.

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In the moments before a match, forcados pray in a farmhouse on the outskirts of Alcáçovas. After the bullfight a far more bacchanalian ritual begins. The group will go to a local tavern or home, then spend long hours toasting their friendship and analyzing their performance.



Following a match in Évora, costumed forcados meet and greet their supporters: friends, family, girlfriends, groupies. "Why do I date them?" one woman asked. "Because soccer and rugby players are boring by comparison." Most forcados are men 17 to 30 years old; few remain in the group once they marry.

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An Évora forcado springs into action as the *pega*, the second act, commences. The first part of a Portuguese bullfight features the *cavaleiro*, a horseman who weakens the bull by sticking it with spears called *bandarilhas*. The *cernelha*—two forcados fighting the bull but using tamer cattle as a distraction—can be used as a last resort.



Shadows of bleacher-seated spectators play on the outer wall of a plaza in Castro Marim. The bullfighting season in Portugal lasts from April through October, with hundreds of matches a year. Most attract several thousand attendees, though a soccer game can trim that figure if slated for the same evening.



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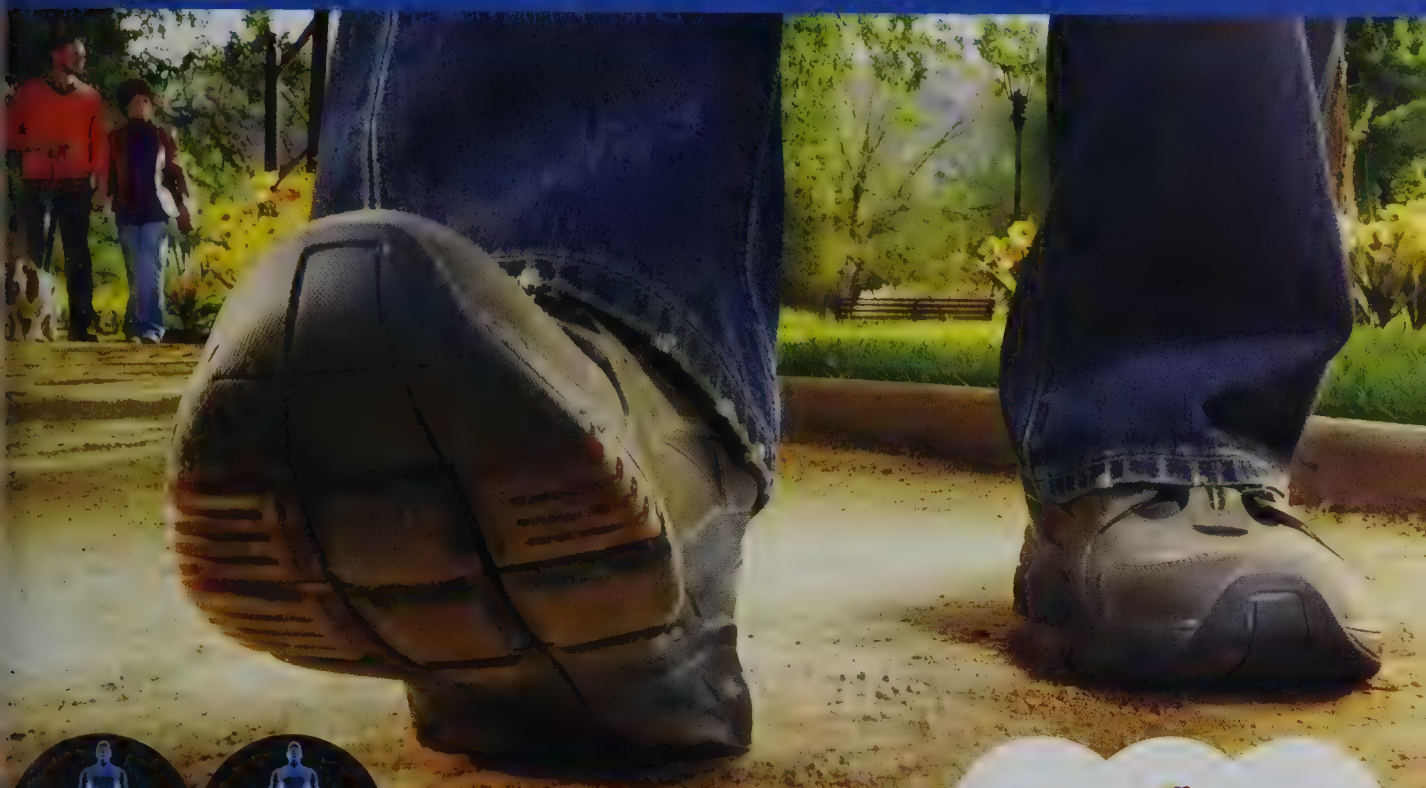


Everything comes to a head in Reguengos de Monsaraz, where the forcados bear the brunt. The man on the bull's horns is the *caras*, tasked with hanging on as long as possible. The one on the right is the *rabejador*, whose job is to get behind the animal and yank its tail, upsetting its equilibrium.



A bouquet of flowers, sure to be tossed into the ring at fight's end, rests in the wooden seats of an arena in Góis, a town in the Coimbra district. Pega enthusiasts throw objects—clothes, candies, dolls, hats—as tokens of luck and gratitude.

This is no walk in the park if you have Diabetic Nerve Pain.



Move towards relief with

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*Nerves damaged by diabetes can send too many signals that cause pain.**

Lyrica is believed to help calm the damaged nerves† - reducing the signals and the pain.

Unlike some common over-the-counter pain relievers, Lyrica is FDA approved specifically to treat the **shooting, stabbing, burning sensations** of diabetic nerve pain. Lyrica is believed to help calm the damaged nerves† and help ease this pain – so a walk in the park can be just that.

Ask your doctor if Lyrica can help you.

*Diagram is illustrative of diabetic nerve pain.

†Exact mechanism of action and relevance to humans are unknown as studies were conducted on animal models.

Prescription Lyrica is not for everyone. Tell your doctor right away about any serious allergic reaction that causes swelling of the face, mouth, lips, gums, tongue or neck or any trouble breathing or that affects your skin. Lyrica may cause suicidal thoughts or actions in a very small number of people. Call your doctor right away if you have new or worsening depression, suicidal thoughts or actions, or unusual changes in mood or behavior. Lyrica may cause swelling of your hands, legs and feet. Some of the most common side effects of Lyrica are dizziness and sleepiness. Do not drive or work with machines until you know how Lyrica affects you. Other common side effects are blurry vision, weight gain, trouble concentrating, dry mouth, and feeling “high.” Also, tell your doctor right away about muscle pain along with feeling sick and feverish, or any changes in your eyesight including blurry vision or any skin sores if you have diabetes. You may have a higher chance of swelling, hives or gaining weight if you are also taking certain diabetes or high blood pressure medicines. Do not drink alcohol while taking Lyrica. You may have more dizziness and sleepiness if you take Lyrica with alcohol, narcotic pain medicines, or medicines for anxiety. If you have had a drug or alcohol problem, you may be more likely to misuse Lyrica. Tell your doctor if you are planning to father a child. Talk with your doctor before you stop taking Lyrica or any other prescription medication.

Please see Important Facts Brief Summary on adjacent page.

To learn more visit www.lyrica.com or call toll-free 1-888-9-LYRICA (1-888-959-7422).

You are encouraged to report negative side effects of prescription drugs to the FDA.

Visit www.FDA.gov/medwatch or call 1-800-FDA-1088.

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IMPORTANT FACTS



(LEER-i-kah)

IMPORTANT SAFETY INFORMATION ABOUT LYRICA

LYRICA may cause serious, even life threatening, allergic reactions. Stop taking LYRICA and call your doctor right away if you have any signs of a serious allergic reaction:

- Swelling of your face, mouth, lips, gums, tongue or neck
- Have any trouble breathing
- Rash, hives (raised bumps) or blisters

Like other antiepileptic drugs, LYRICA may cause suicidal thoughts or actions in a very small number of people, about 1 in 500.

Call your doctor right away if you have any symptoms, especially if they are new, worse or worry you, including:

- New or worsening depression
- Suicidal thoughts or actions
- Unusual changes in mood or behavior

Do not stop LYRICA without first talking with your doctor.

LYRICA may cause swelling of your hands, legs and feet.

This swelling can be a serious problem with people with heart problems.

LYRICA may cause dizziness or sleepiness.

Do not drive a car, work with machines, or do other dangerous things until you know how LYRICA affects you. Ask your doctor when it is okay to do these things.

ABOUT LYRICA

LYRICA is a prescription medicine used in adults 18 years and older to treat:

- Pain from damaged nerves that happens with diabetes or that follows healing of shingles
- Partial seizures when taken together with other seizure medicines
- Fibromyalgia (pain all over your body)

Who should NOT take LYRICA:

- Anyone who is allergic to anything in LYRICA

BEFORE STARTING LYRICA

Tell your doctor about all your medical conditions, including if you:

- Have had depression, mood problems or suicidal thoughts or behavior
- Have or had kidney problems or dialysis
- Have heart problems, including heart failure
- Have a bleeding problem or a low blood platelet count
- Have abused prescription medicines, street drugs or alcohol in the past
- Have ever had swelling of your face, mouth, tongue, lips, gums, neck, or throat (angioedema)
- Plan to father a child. It is not known if problems seen in animal studies can happen in humans.
- Are pregnant, plan to become pregnant or are breastfeeding. It is not known if LYRICA will harm your unborn baby. You and your doctor should decide whether you should take LYRICA or breast-feed, but not both.

Tell your doctor about all your medicines. Include over-the-counter medicines, vitamins, and herbal supplements.

LYRICA and other medicines may affect each other causing side effects. Especially tell your doctor if you take:

- Angiotensin converting enzyme (ACE) inhibitors. You may have a higher chance for swelling and hives.

BEFORE STARTING LYRICA, continued

- Avandia® (rosiglitazone)*, Avandamet® (rosiglitazone and metformin)* or Actos® (pioglitazone)** for diabetes. You may have a higher chance of weight gain or swelling of your hands or feet.
- Narcotic pain medicines (such as oxycodone), tranquilizers or medicines for anxiety (such as lorazepam). You may have a higher chance for dizziness and sleepiness.
- Any medicines that make you sleepy

POSSIBLE SIDE EFFECTS OF LYRICA

LYRICA may cause serious side effects, including:

- See "Important Safety Information About LYRICA."
- Muscle problems, pain, soreness or weakness along with feeling sick and fever
- Eyesight problems including blurry vision
- Weight gain. Weight gain may affect control of diabetes and can be serious for people with heart problems.
- Feeling "high"

If you have any of these symptoms, tell your doctor right away.

The most common side effects of LYRICA are:

- Dizziness
- Trouble concentrating
- Blurry vision
- Swelling of hands and feet
- Weight gain
- Dry mouth
- Sleepiness

If you have diabetes, you should pay extra attention to your skin while taking LYRICA and tell your doctor of any sores or skin problems.

HOW TO TAKE LYRICA

Do:

- Take LYRICA exactly as your doctor tells you. Your doctor will tell you how much to take and when to take it. Take LYRICA at the same times each day.
- Take LYRICA with or without food.

Don't:

- Drive a car or use machines if you feel dizzy or sleepy while taking LYRICA.
- Drink alcohol or use other medicines that make you sleepy while taking LYRICA.
- Change the dose or stop LYRICA suddenly. You may have headaches, nausea, diarrhea, or trouble sleeping if you stop taking LYRICA suddenly.
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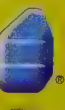
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VISIONS OF EARTH



Switzerland Curiosity seekers stroll inside a crop circle etched in a Corcelles-près-Payerne wheat field in 2007. More than 200 feet in diameter, the pattern was spied by a Swiss military pilot flying over the Broye region.

PHOTO: SANDRO CAMPARDO, EPA/CORBIS



Cameroon At the Sanaga-Yong Chimpanzee Rescue Center, more than a dozen residents form a gallery of grief, looking on as Dorothy—a beloved female felled in her late 40s by heart failure—is borne to her burial.





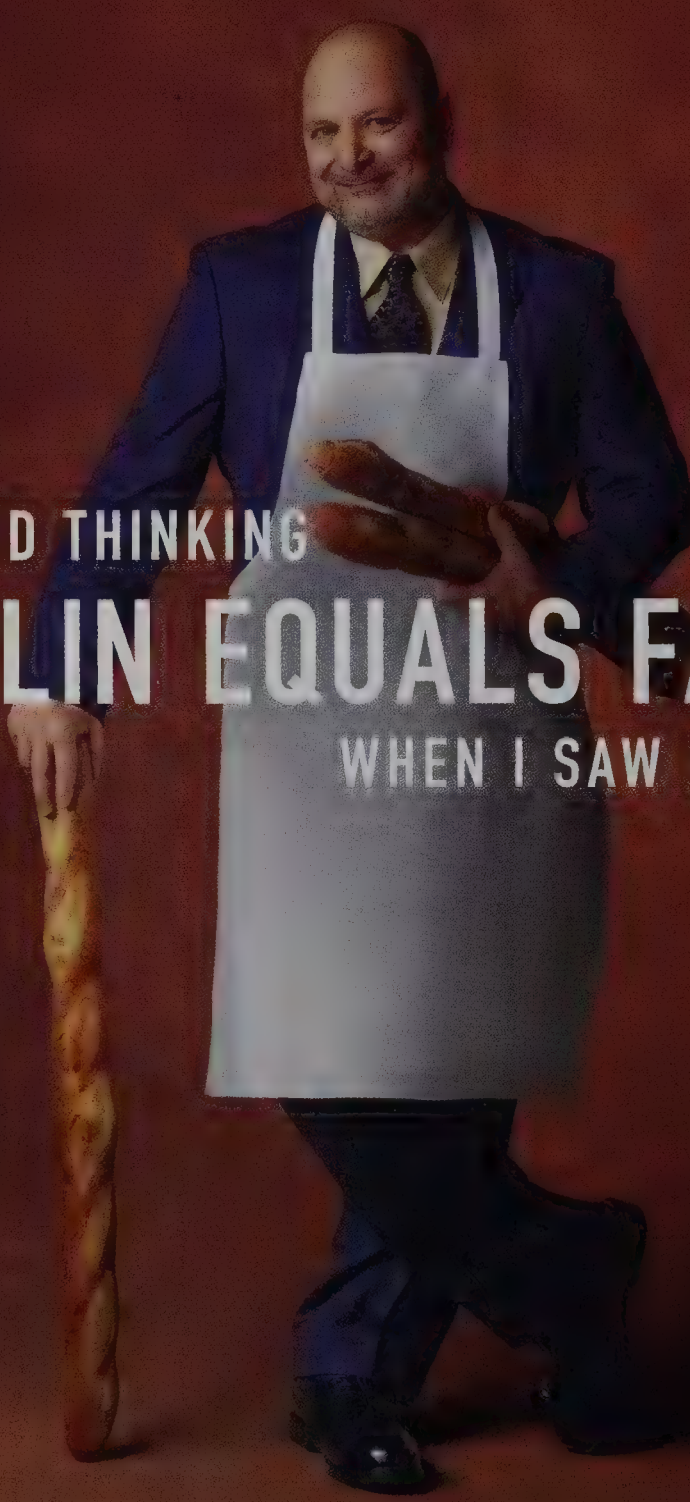
Antarctica Radiating charisma on a 23°F morning, a three-foot-tall emperor penguin strikes a pose on the pack ice of the Amundsen Sea. The photographers were taking a month-long cruise aboard a Russian icebreaker.





Individual results may vary.

sanofi aventis

A middle-aged man with a beard, wearing a dark blue suit, a patterned tie, and a white apron, stands against a dark red background. He is smiling and holding a long, braided loaf of bread in his right hand and a smaller piece of bread in his left hand. The text is overlaid on the image.

**"I STOPPED THINKING
INSULIN EQUALS FAILURE
WHEN I SAW MY NUMBERS."**

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GREG PFAFF

DELI OWNER

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"I tried to manage my type 2 diabetes with diet, exercise, and pills, so when my doctor said I should add insulin to my therapy, I felt like I'd failed. But he said adding insulin is just replacing what your body should make naturally, and it unlocks your cells so sugar can get in to make energy. Millions of people with diabetes take insulin every day to help reach their blood sugar goals. That's not failure—it's success. Now when I look at my blood sugar numbers, I have only one regret: that I didn't add insulin sooner." **RETHINK INSULIN**

**SEE MORE OF GREG'S STORY AT
WWW.GOINSULIN.COM**

Important Safety Information About Insulin

Possible side effects may include blood sugar levels that are too low, injection site reactions, and allergic reactions, including itching and rash. Tell your doctor about all other medicines and supplements you are taking because they could change the way insulin works. Glucose monitoring is recommended for all patients with diabetes.



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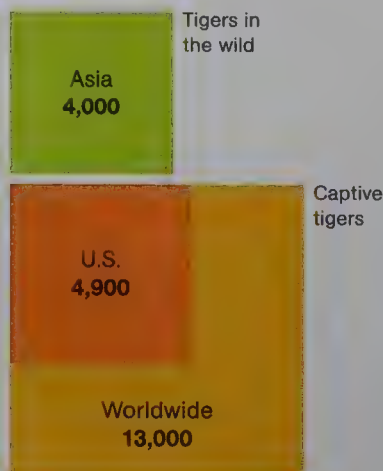
RETHINK INSULIN



Floridian Vernon Yates charms kids when he shows them his cubs. Tiger experts deplore the practice.

A WORLD OF TIGERS

Privately held tigers far exceed wild ones. Zoos hold relatively few.



Don't Hold That Tiger Vernon Yates took one of his 18 tigers to a party—his fee varies by event. “You can’t trust tigers,” a guest said. To prove her wrong, he told her he’d stick his head in the animal’s jaws and tug its tongue for \$20. She had to pay up.

The money goes to Yates’s Wildlife Rescue and Rehabilitation shelter, licensed by Florida to take in animals in distress. “I deal with the true dirt of society,” he says, telling of emaciated cats in squalid cages. He makes no apologies for his controversial style. He brings leashed cubs to schools for educational talks and takes his tigers on truck rides. Other rescuers are strictly hands-off. Contact can stress the animal and endanger humans, says Carole Baskin, a real estate investor who founded Big Cat Rescue, also in Florida. Indeed, between 1996 and 2008 the world’s captive tigers killed at least 52 people and injured many more, from park guests to zookeepers.

One thing rescuers agree on: Cubs are cute, but a 500-pound cat with \$7,500 yearly upkeep isn’t an apt pet. More states are curtailing trade. But Louis Dorfman of the International Exotic Animal Sanctuary says, “There’s always people who’ll sell you a tiger.” —Marc Silver

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Flighty Oaks

In the National Arboretum's parched herbarium, where dried plants date to the 1790s, Alan Whitemore is providing needed acorn perspective. A year after few fell in parts of the U.S., the botanist says hungry squirrels and an anxious press—which breathlessly wondered, Is it climate change?—can relax.

Oak trees, he explains, don't have regular cycles or produce big harvests every year. Factor in weather—cold, wet springs impair pollination; hot, dry summers hinder maturation—and you've got acorn variability.

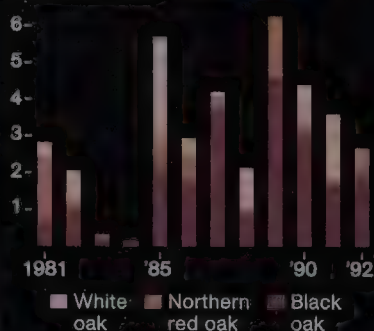
UCLA biologist Victoria Sork concurs. Back in the 1980s she tallied two near-zero years in eastern Missouri. The next fall? A bumper acorn crop. "We have to be careful about reading too much into one year," she says.

Meantime, says botanist Rod Simmons, the next boom year will be a boon year for all. One huge oak can drop up to 10,000 acorns, so well-fed squirrels are likely to hoard and forget their leftovers—and thus plant trees far and wide. —Jeremy Berlin

THE ACORN CYCLE

Oak species' acorn production can vary widely from year to year.

Average acorn production per tree sampled in eastern Missouri (in thousands)



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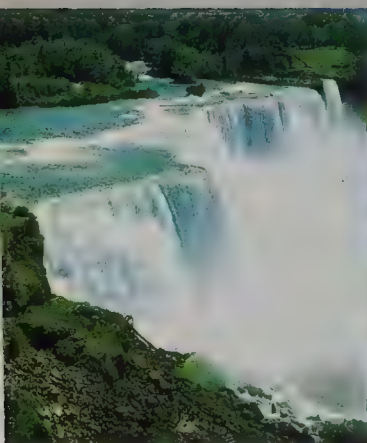


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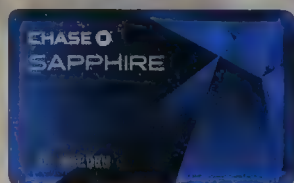
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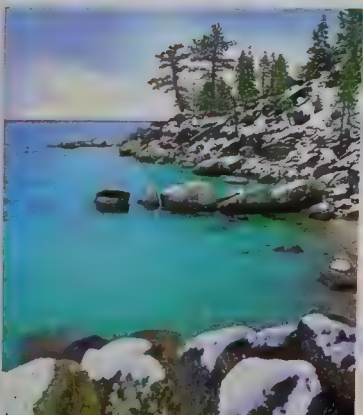
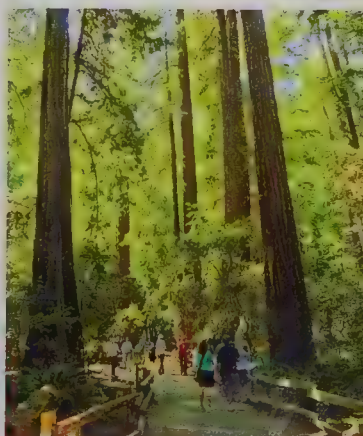
See the "real Tahoe" on this private tour with a professional photographer who will point out Tahoe's best views. Whether it's wildflowers, raging waterfalls, or backcountry beauty, this photo tour will take you there.

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Web of Mystery Bushes, trees, an entire car shrouded in a ghostly white web—the sights last spring in the Dutch city of Rotterdam were like something from a horror film. People were “peering into the hedgerow expecting the mother of all spiders to emerge,” says Stuart Hine, a British Natural History Museum entomologist. What was responsible for this spooky mess?



Not a giant, *Harry Potter*-esque arachnid, says Hine, head of a team that IDs mysterious bugs from around the world. The real culprits were the larvae of flying insects known as ermine moths, so named because their white wings with black spots resemble a certain

weasel’s winter coat. The caterpillars create these silky veils when they’re trying to eat enough greenery to sustain themselves through weeks of cocooning and post-metamorphosis life as moths. Hine guesses that in the widely publicized Rotterdam incidents the bugs simply ran out of trees and randomly descended on a car (below). Weird as the giant webs can look, it’s normal for these caterpillars to spin them. The larvae’s feeding seldom causes lasting tree damage, and the adults are useful plant pollinators. And, Hine adds, “Once they’re out of their cocoons, they’re lovely little moths.” —Chris Carroll



TAKEN WING
Several ermine moth species inhabit Europe. Hundreds more live elsewhere in the world.



After defoliating trees, caterpillars turned their attention to something less edible in Rotterdam, Netherlands.

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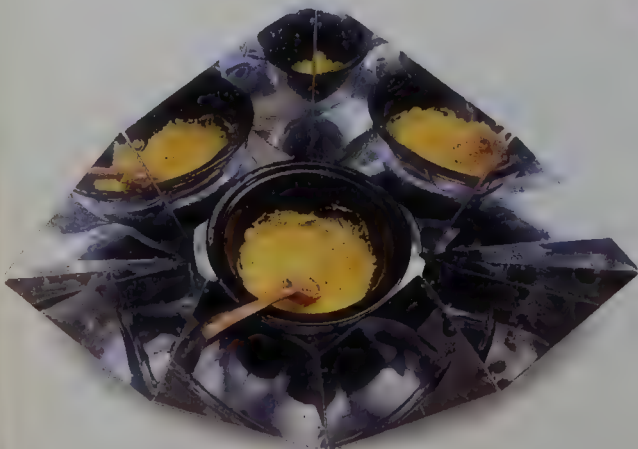
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Apollo's Oven

In desert villages in Chile, 250 families are glad to let the sun roast their goat meat. The UN Development Programme paid \$110 for the wood to build each solar oven. Fuel is free; pollution is nil. Women can spend time with kids instead of gathering wood. Solar Cookers International estimates one to two million solar ovens are now in villages, refugee camps, and sunny cities.

More are coming. This year Jon Bøhmer, a Norwegian living in Kenya, won a \$75,000 "green" prize for devising a \$7 version of a cardboard box oven (right) that can disinfect water and cook food. He's now working to distribute 10,000 equally cheap but more durable plastic ovens.

Skeptics might wonder if the sun can finish a dish. Ask Washington, D.C., pastry chef Michaela Borghese. She's honing her solar technique so she can do demos in the developing world. After an hour in the HotPot, with no stirring, her polenta (below) was creamy and delicious. And you should taste her buttery solar linzer torte. —Marc Silver



BUY IT

With aluminum panels and a black pot in a glass bowl, the HotPot (left) can hit 300°F. Its retail price is about \$100. In poor areas, Solar Household Energy subsidizes a \$40 HotPot with cardboard reflectors.

BUILD IT

A no-frills solar box oven, a favorite of do-it-yourselfers since the 1970s, is easy to assemble. This one hit and held 195°F on a mostly sunny June day—more than enough heat to pasteurize water.

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Qat Goes Global Grab a bitter leaf and chew. Then take another and another, letting the wad rest in your cheek. Soon you'll feel less hungry, more alert, a little euphoric. That's qat (pronounced cot, often spelled khat), a stimulant used for centuries in Yemen and Africa's Horn by laborers for energy and by men to while away afternoons. Today, with increased urbanism, easier access to cash, and relaxed social mores, it's taking deeper root. "People chew it in the early morning, on the street," says psychologist Michael Odenwald. "Children and breast-feeding women chew it."

Qat's fanning out too, flown daily to African and Yemeni expats in Europe, Australia, and North America while also entering Uganda and Rwanda. With greater demand and better transport—which gets qat to market in 48 hours, while it's still fresh and potent—farmers are planting more of the profitable, easy-to-grow crop. In Yemen, the cultivated area has increased more than tenfold since 1970; in Ethiopia, qat has become a top foreign-exchange earner.

The plant's spread raises concerns, though. In Yemen, it's irrigated from shrinking aquifers. In Somalia, Odenwald has seen abuse linked to mental-health problems. And in the West, countries have debated whether to leave the leaf legal, like tobacco, or ban it, like marijuana. Qat will get you arrested in the U.S., Canada, and much of Europe. In the U.K., for now, it's perfectly fine. —Karen E. Lange



STIMULATING DEBATE

A stem of qat (above) is bundled with others (below) to become an international commodity—and a controversial drug.



A seller in Hargeysa, Somaliland, offers enough qat for an afternoon of chewing. The price: \$10.

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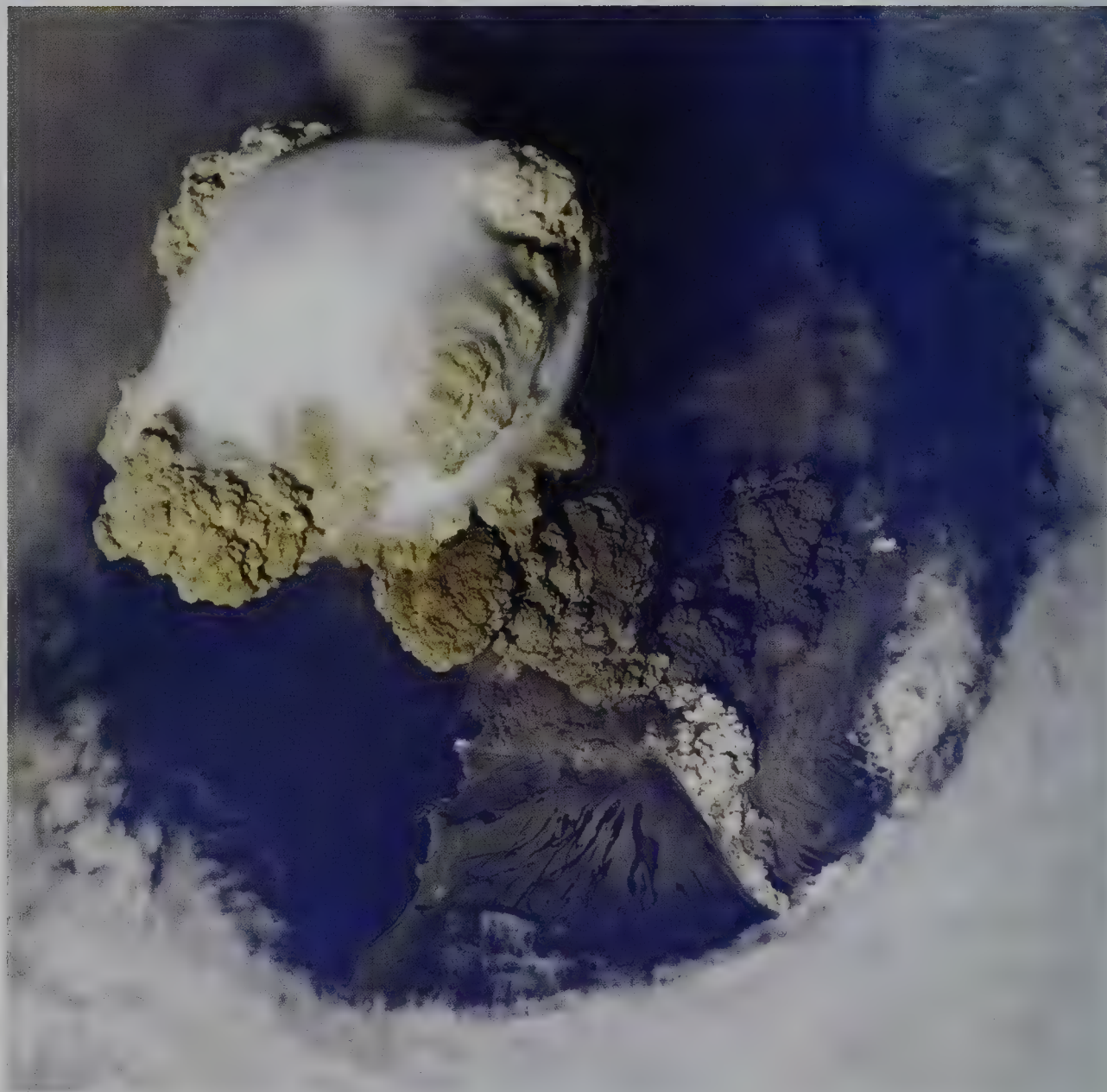
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WHERE IN THE WORLD?



Erupting periodically since 1760, Sarychev Peak is now one of the Kuril Islands' most active volcanoes.

Sarychev Goes Boom A hot fist of steam and ash punches through the cloud cover above the Sarychev volcano on Matua Island, part of the remote Kuril Islands chain off Russia and Japan. Crew members on the International Space Station captured this image on June 12, 2009, soon after the mountain burst open. Over three days the ash column topped 50,000 feet, diverting air travel as debris and sulfur dioxide belched skyward.

The smooth white cap atop the plume is likely a pileus cloud—a transient puff of condensation that forms when a climbing air mass cools above an ash column. But the cloud peephole is an enigma. It may have resulted from the eruption's shock wave, or from evaporation as air sank and warmed around the plume. Or perhaps it was simply a lucky window onto the epic blast. —Jennifer S. Holland

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It happened on our last trip to South America. After visiting the "Lost City" of Machu Picchu in Peru, we ventured through the mountains and down the Amazon into Brazil. In an old village we met a merchant with an impressive collection of spectacular, iridescent emeralds. Each gem was tumbled smooth and glistened like a perfect rain forest dew drop. But the price was so unbelievable, I was sure our interpreter had made a mistake.

But there was no mistake. And after returning home, I had 20 carats of these exquisite emeralds strung up in 14k gold and wrapped as a gift for my wife's birthday. That's when my trouble began. She loved it. Absolutely adored it. In fact, she rarely goes anywhere without the necklace and has basked in compliments from total strangers for months now.

So what's the problem? I'm never going to find an emerald deal this good again. In giving her such a perfect gift, I've made it impossible to top myself.

To make matters worse, my wife's become obsessed with emeralds. She can't stop sharing stories about how Cleopatra cherished the green gem above all others and how emeralds were worshiped by the Incas and Mayans and prized by Spanish conquistadors and Indian maharajahs. She's even buying into ancient beliefs that emeralds bring intelligence, well-being and good luck to anyone who wears them. I don't have the heart to tell her that I'm never going to find another deal this lucky.



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Ahoy, Reindeer The antlered animals weren't made for this—to stumble onto a boat in the middle of an autumn night (below) and bump and sway on the water for six hours until they attain solid ground again and resume their overland migration to a winter refuge. In Norway, both reindeer and their seminomadic herders, members of the indigenous Sami, are struggling to find their balance as development intrudes on traditional grazing lands, changing the way humans and animals move.

For centuries the Sami have seasonally driven reindeer between grassy feeding grounds on the coast and lichen-rich tundra in the interior. Unlike the tiny wild population to the south, the 250,000 northern reindeer are semidomesticated, raised principally for the sale of their meat. The income helps support about 3,000 herders, nowadays a small fraction of Norway's Sami population of 50,000.

But no longer can herds drift as easily as clouds. A glut of holiday cabins, oil and gas complexes, military ranges, windmill farms, and power lines has fragmented migration corridors. To adapt, the Sami are shifting grazing areas and using boats as well as trucks to maneuver herds. With the loss of pastureland, some worry that the culture's long dependence on reindeer will slowly vanish, destined for tales told by elders. —Tom O'Neill



Migration of Norwegian reindeer by land and sea may take more than a week and cover over 120 miles.



To skirt development, some of Norway's reindeer now migrate partly by boat, in packs of 600 or so.



"Henry Philip Hope would be impressed with the superfine deep blue of the Stauer *Eternal Hope* Necklace. Ever since the original first surfaced centuries ago, it has been shrouded in legend and mystery."

— JAMES T. FENT,
Stauer GIA
Graduate Gemologist

This colossal stone of more than 45 carats is enlarged to show details.

World's Most Famous Diamond Found Inside Toaster

Stauer introduces a scientifically created tribute to the legendary Hope Diamond!

It's a wonder that the *Hope Diamond* survived the 20th century. In the hands of eccentric millionaire heiress Evalyn Walsh McLean, the 45 ½ carat deep blue diamond was treated more like a fancy plaything than a precious gem. McLean wore it on rollercoasters, while swimming and when doing yard work. She hid it underneath couch cushions and from time to time, even kept it inside her toaster!

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When being called a "jewel thief" is a badge of honor. The final product is so convincing that it will surely have museum curators double checking their vault. Our update keeps the allure of the original, the magic that captivated Maharajahs, kings and queens.

The custom-cut stone is brilliant cobalt blue lab-created spinel. Spinel is considered the greatest impostors in gemstone history. One of the most valuable gemstones in the world, the *Black Prince* in the British Crown Jewels, was only recently discovered to be a spinel. They are favored by jewelers because of their brilliance and hardness. And the structure of a spinel is similar to a diamond—they both have the same high symmetry (4/m bar 3 2/m).

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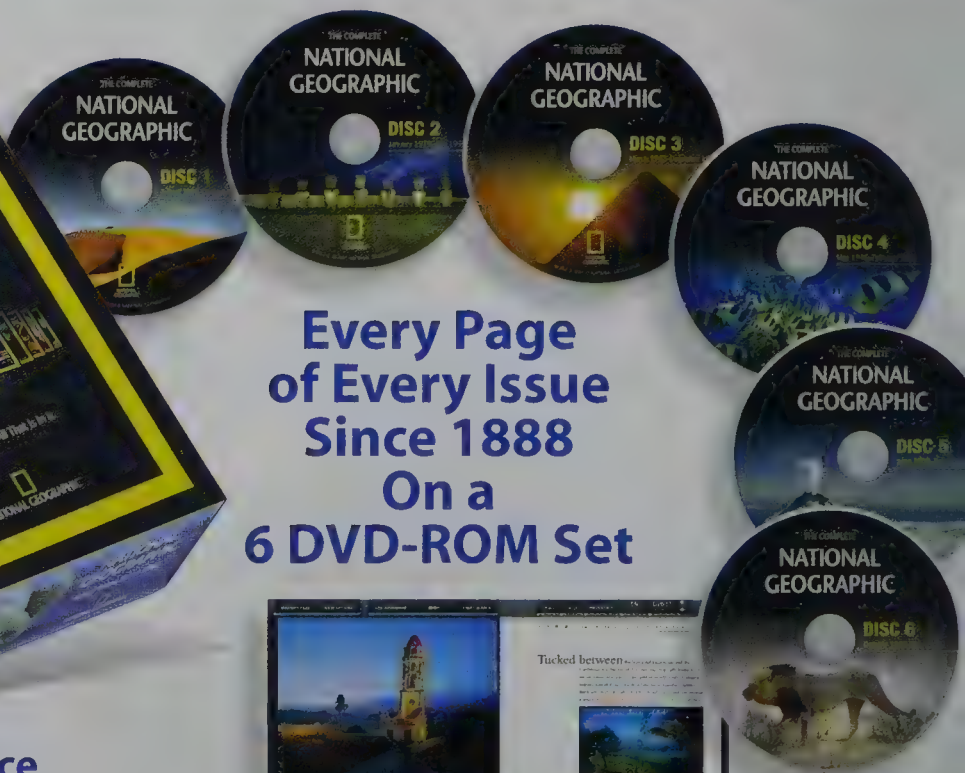
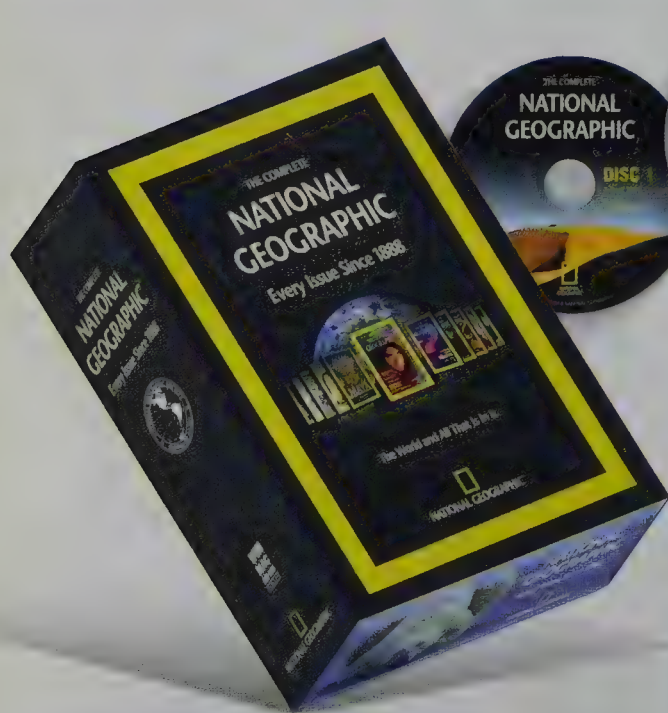


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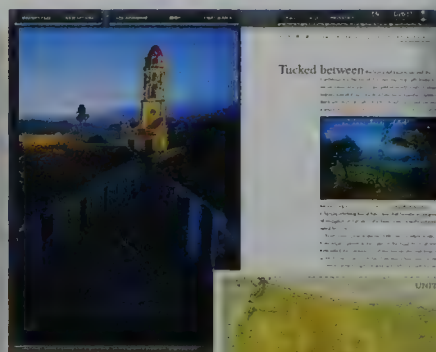
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Truly Unique



Time travel at the speed of a 1935 Speedster?

The 1930s brought unprecedented innovation in machine-age technology and materials. Industrial designers from the auto industry translated the principles of aerodynamics and streamlining into everyday objects like radios and toasters. It was also a decade when an unequaled variety of watch cases and movements came into being. In lieu of hands to tell time, one such complication, called a jumping mechanism, utilized numerals on a disc viewed through a window. With its striking resemblance to the dashboard gauges and radio dials of the decade, the jump hour watch was indeed "in tune" with the times!

The Stauer 1930s Dashtronic deftly blends the modern functionality of a 21-jewel automatic movement and 3-ATM water resistance with



True to Machine Art esthetics, the sleek brushed stainless steel case is clear on the back, allowing a peek at the inner workings.

the distinctive, retro look of a jumping display (not an actual jumping complication). The stainless steel 1 1/2" case is complemented with a black alligator-embossed leather band. The band is 9 1/2" long and will fit a 7-8 1/2" wrist.

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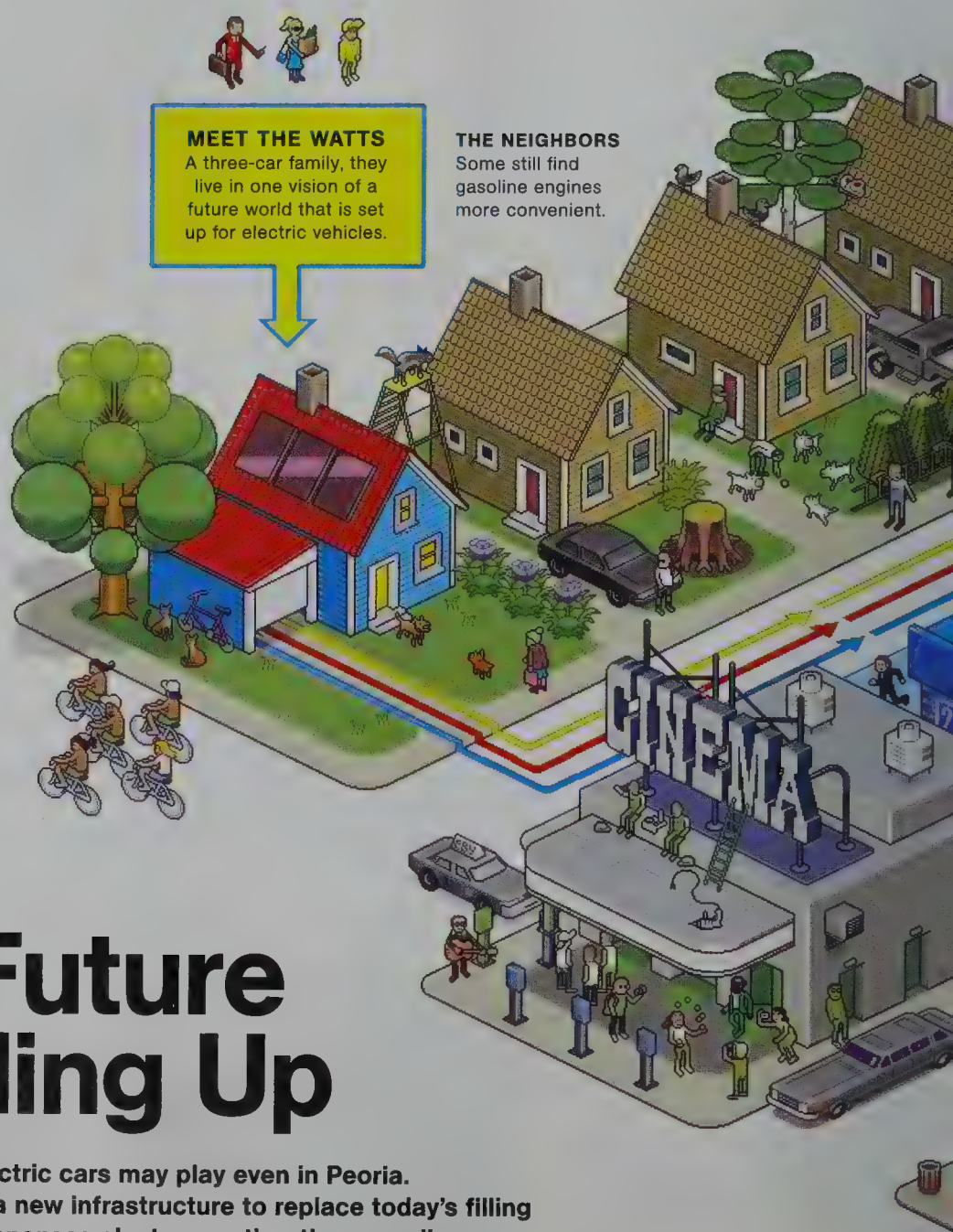
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The Future of Filling Up

This time around, electric cars may play even in Peoria. But they will require a new infrastructure to replace today's filling stations—one that dispenses electrons rather than gasoline.

In the future most cars will run on electricity from sun, wind, and water. Plug-in electric vehicles will hum along streets, giving off no exhaust. Oil imports and greenhouse gas emissions will fall. Smog will lift. At least that's the vision many people are hoping will become reality. But first there are a few logistical problems to work out, including this one: Just where are all these revolutionary new cars going to plug in?

Between 2010 and 2012, car manufacturers are planning to introduce dozens of models that

are either partially or completely powered by rechargeable batteries. Plug-in hybrid vehicles like the Chevy Volt, which will have a gasoline engine to fall back on after about 40 miles, will take up to eight hours to charge on ordinary 120-volt household current; some all-electric vehicles, with larger batteries designed to provide a range of 100 to 200 miles, will need 10 to 12 hours. Many homes have 240-volt outlets (used to run clothes dryers) that could in principle cut the time in half, and much charging can be done overnight, when



GREEN POWER
Electric cars will be clean only when their power source is; most electricity today comes from fossil fuels.



Bob, like most commuters, charges his car at home overnight. His "smart meter" automatically starts the process when rates go down and stops when the battery is full. A charging station at the office allows him to top off.

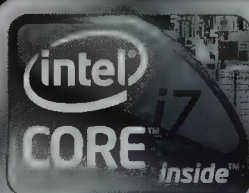


Sonia's "neighborhood car" goes just 20 miles on a full charge, but a dashboard computer locates available charging outlets and alerts her if the power company shuts them down to meet high demand elsewhere.



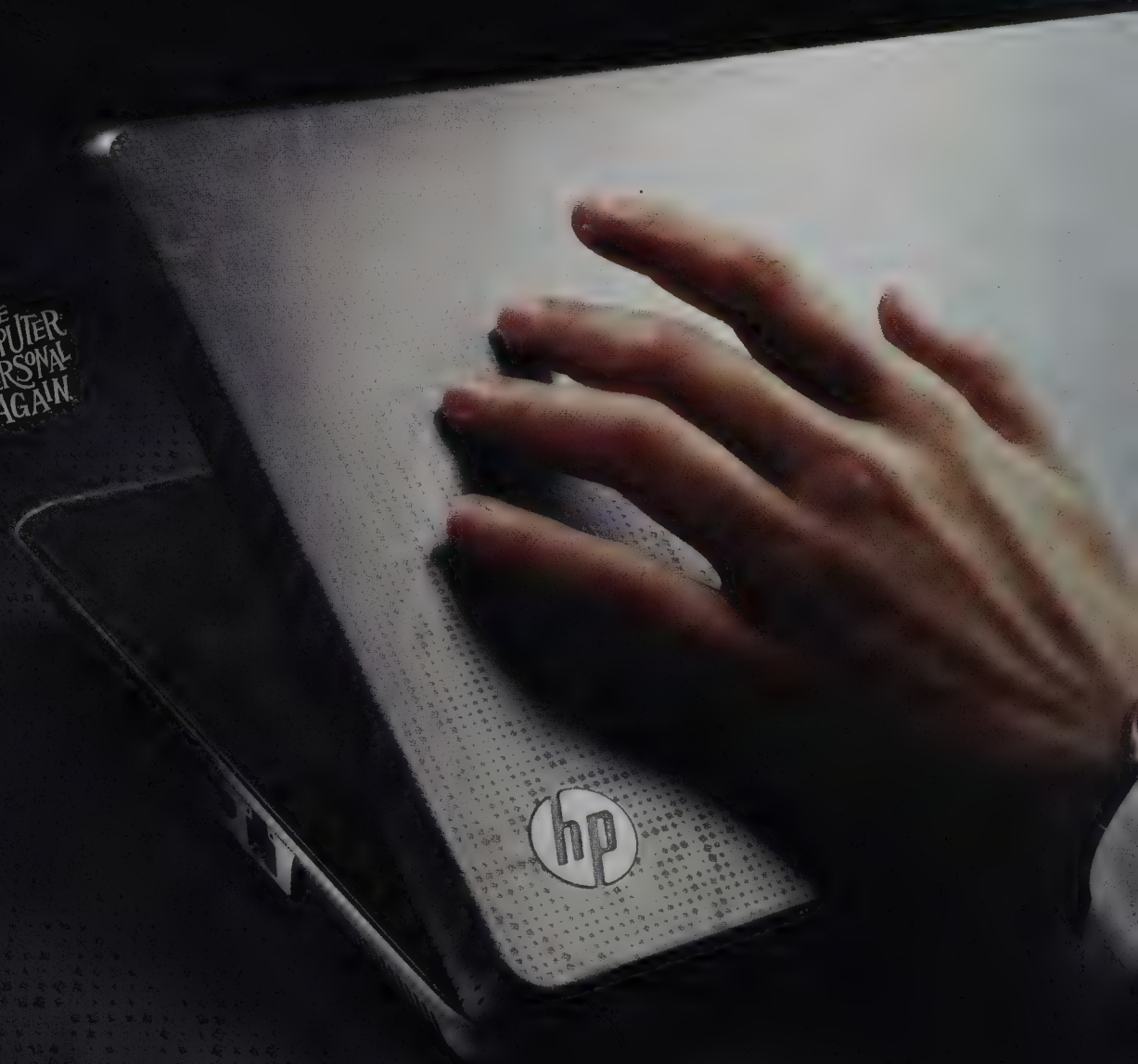
Justin takes his sports car on road trips. Filling up on the highway may mean pulling into a robotic battery-switching station or plugging into a high-voltage charger that fills the battery in 20 minutes or so.

Windows®. Life without Walls.™ HP recommends Windows 7.



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When you combine the unmatched intelligent performance of the Intel® Core™ i7 processor with cutting-edge design, you get the new HP Envy 15. Experience work and play with the ultimate expression of form and function. hp.com/go/envy



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COST

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2 cents



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1 lb



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With electricity from coal

0 lb

With electricity from renewable sources

RANGE IN MILES

350



100



ELECTRIC



The average American car gets nearly 21 mpg and emits about a pound of CO₂ per mile.

An electric car runs cheaper and cleaner, but it costs more up front and has a shorter range.

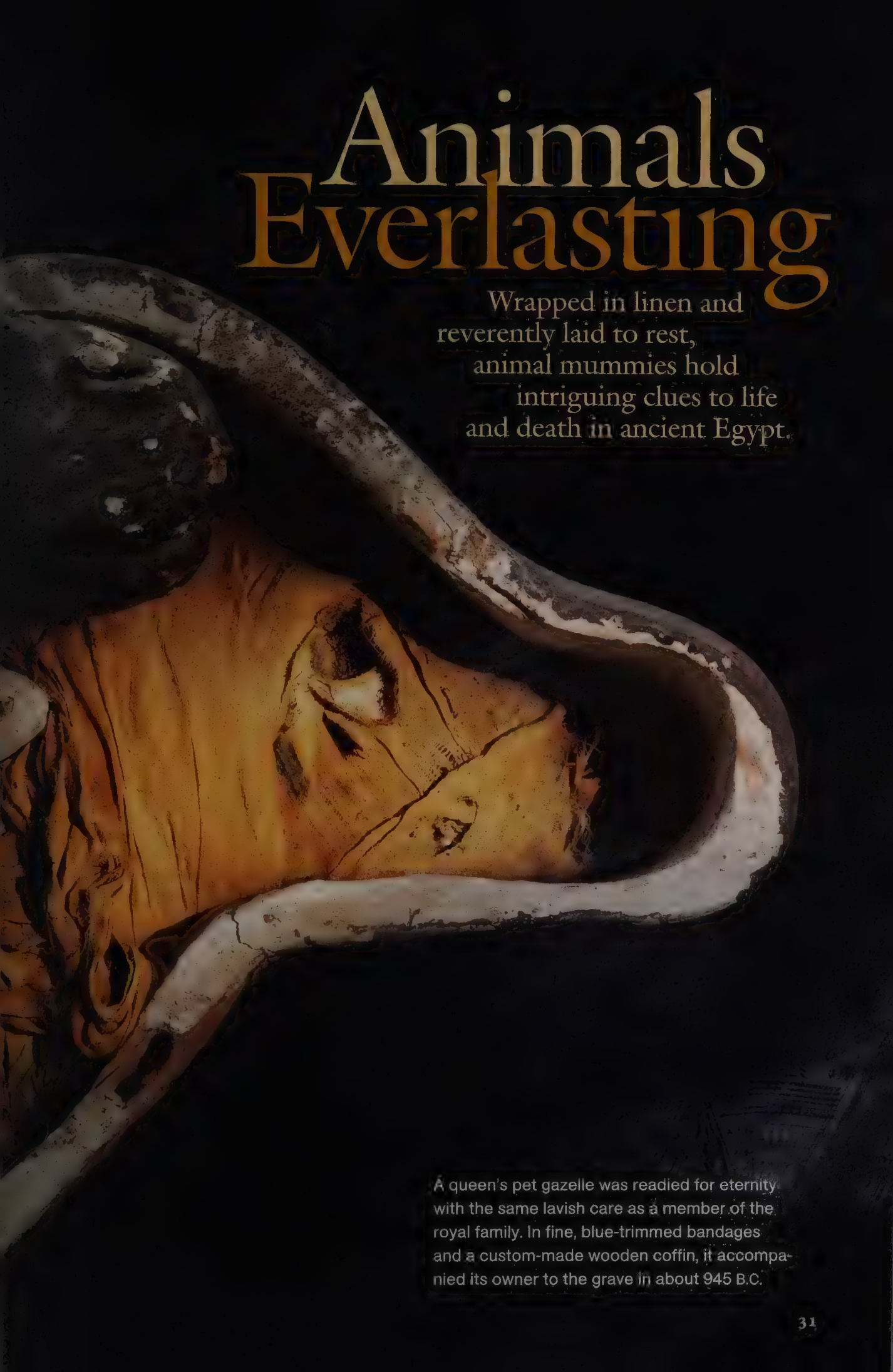
electricity is relatively cheap. Still, in order for lots of people to adopt electric cars, there will have to be a network of charging stations—places where apartment dwellers, commuters who want to top off at work, and highway travelers can plug in. “You don’t want to put out too much infrastructure if you don’t have the vehicles,” says Art James of the Oregon Department of Transportation. “But you won’t get the vehicles until you have the infrastructure.”

That infrastructure is starting to emerge in scattered places around the world, especially where governments are encouraging it. In Israel, a country with expensive gasoline and short driving distances, a California-based company called Better Place has constructed more than a thousand charging stations; next year it hopes to begin building a similar network in the San Francisco area. Under the Better Place plan, the company owns and tracks the use of the expensive lithium-ion batteries in its subscribers’ cars; they pay a fee to recharge, even when they’re

recharging at home. That lowers the cars’ initial cost by a third or more, but customers must buy from manufacturers that have agreed to use Better Place’s standard batteries; so far only Renault-Nissan has signed on. To allow extended highway travel, Better Place will also build switching stations where robots swap out drained batteries for charged ones in a few minutes.

Alternatively, the future may look more like the present, with drivers of any brand of car able to pull into any brand of service station. Coulomb Technologies, another California start-up, claims it could build high-speed, 480-volt charging stations that would allow highway travelers to fill up in 20 minutes—about the time it takes for a rest stop. With 117,000 gas stations in the United States today and fewer than 500 charging stations, many not even open to the public, the scale of the transition to an electric-car world is daunting. But so are high gasoline prices and a warming climate. Says James, “It’s going to happen quicker than you think.” —Karen E. Lange





Animals Everlasting

Wrapped in linen and
reverently laid to rest,
animal mummies hold
intriguing clues to life
and death in ancient Egypt.

A queen's pet gazelle was readied for eternity with the same lavish care as a member of the royal family. In fine, blue-trimmed bandages and a custom-made wooden coffin, it accompanied its owner to the grave in about 945 B.C.



BY A. R. WILLIAMS

PHOTOGRAPHS BY RICHARD BARNES

In 1888 an Egyptian farmer digging in the sand near the village of Istabl Antar uncovered a mass grave. The bodies weren't human. They were feline—ancient cats that had been mummified and buried in pits in staggering numbers. “Not one or two here and there,” reported the *English Illustrated Magazine*, “but dozens, hundreds, hundreds of thousands, a layer of them,

a stratum thicker than most coal seams, ten to twenty cats deep.” Some of the linen-wrapped cats still looked presentable, and a few even had gilded faces. Village children peddled the best specimens to tourists for change; the rest were sold in bulk as fertilizer. One ship hauled about 180,000, weighing some 38,000 pounds, to Liverpool to be spread on the fields of England.

Those were the days of generously funded expeditions that dredged through acres of desert in their quest for royal tombs and for splendid gold and painted masks and coffins to adorn the estates and museums of Europe and America. The many thousands of mummified animals that turned up at sacred sites throughout Egypt were just things to be cleared away to get at the good stuff. Few people studied them, and their importance was generally unrecognized.

In the century since then, archaeology has become less of a trophy hunt and more of a science. Excavators now realize that much of their sites' wealth lies in the multitude of details about ordinary folks—what they did, what they thought, how they prayed. Animal mummies are a big part of that pay dirt.

“They're really manifestations of daily life,” says Egyptologist Salima Ikram. “Pets, food,

Pampered in a temple during its lifetime, a sacred baboon was enshrined after death in the Tuna el-Gebel catacombs. Priests prayed and made offerings to it there as signs of their abiding reverence.

death, religion. They cover everything the Egyptians were concerned with.” Specializing in zooarchaeology—the study of ancient animal remains—Ikram has helped launch a new line of research into the cats and other creatures that were preserved with great skill and care. As a professor at the American University in Cairo, she adopted the Egyptian Museum's languishing collection of animal mummies as a research project. After taking precise measurements, peering beneath linen bandages with x-rays, and cataloging her findings, she created a gallery for the collection—a bridge between people today and those of long ago. “You look at these animals, and suddenly you say, Oh, King So-and-So had a pet. I have a pet. And instead of being at a distance of 5,000-plus years, the ancient Egyptians become people.”

Today the animal mummies are one of the most popular exhibits in the whole treasure-filled museum. Visitors of all ages, Egyptians and foreigners, press in shoulder to shoulder to get a look. Behind glass panels lie cats wrapped in strips of linen that form diamonds, stripes, squares, and crisscrosses. Shrews in boxes of carved limestone. Rams covered with gilded and beaded casings. A gazelle wrapped in a tattered mat of papyrus, so thoroughly flattened by mummification that Ikram named it Roadkill. A 17-foot, knobby-backed crocodile, buried with baby croc mummies in its mouth. Ibises in bundles with intricate appliqués. Hawks. Fish. Even tiny scarab beetles and the dung balls they ate.

Some were preserved so that the deceased

Votive mummies, each buried with a prayer, are infinitely varied but not always what they seem. Counterclockwise from top: A cunning crocodile is a fake—it has nothing inside. A coffered linen bundle conceals an ibis. A shrew on a tiny stone coffin identifies the contents precisely. Papyrus and linen trace the contours of a gazelle. A raptor with an appliqué face holds only a few bones.









Meat mummies on display at the Egyptian Museum in Cairo were prepared as a royal picnic for the afterlife. Ducks, legs of beef, ribs, roasts, and even an oxtail for soup were all dried in natron, bound in linen, and packed in a reed basket for burial in a queen's tomb.



would have companionship in eternity. Ancient Egyptians who could afford it prepared their tombs lavishly, hoping that their assembled personal items, and everything shown in specially commissioned works of art, would magically be available to them after death. Beginning in about 2950 B.C., kings of the 1st dynasty were buried at Abydos with dogs, lions, and donkeys in their funerary complexes. More than 2,500 years later, during the 30th dynasty, a commoner at Abydos named Hapi-men was laid to rest with his small dog curled at his feet.

Other mummies were provisions for the dead. The best cuts of beef, succulent ducks, geese, and pigeons were salted, dried, and wrapped in linen. “Victual mummies” is what Ikram calls this gourmet jerky for the hereafter. “Whether or not you got it regularly in life didn’t matter because you got it for eternity.”

And some animals were mummified because they were the living representatives of a god. The venerable city of Memphis, the capital for much of Egypt’s ancient history, covered 20

square miles at its largest in about 300 B.C., with a population of some 250,000. Today most of its crumbled glory lies under the village of Mit Rahina and the surrounding fields. But along a dusty lane, the ruins of a temple stand half hidden amid tufts of grass. This was the embalming house of the Apis bull, one of the most revered animals in all of ancient Egypt.

A symbol of strength and virility, the Apis was closely linked to the all-powerful king. He was part animal, part god and was chosen for veneration because of his unusual set of markings: a white triangle on his forehead, white winged patterns on his shoulders and rump, a scarab silhouette on his tongue, and double hairs at the end of his tail. During his lifetime he was kept in a special sanctuary, pampered by priests, adorned with gold and jewels, and worshipped by the multitudes. When he died, his divine essence was believed to move on to another bull, and so a search for the new one began. Meanwhile, the body of the deceased was transported to the temple and laid on a bed of finely carved travertine. Mummification took at least 70 days—40 to dry the enormous repository of flesh, and 30 to wrap it.

On the bull’s burial day, city residents surged

A. R. Williams is a senior writer for the magazine. Richard Barnes’s recent book, *Animal Logic*, offers a behind-the-scenes look at natural history museums.





Ever so gently, archaeologist Salima Ikram flicks at caked mud to free an ibis from the earthenware jar it was buried in 2,700 years ago at Abydos. Back then, millions of stilt-legged ibises bobbed for food in the fertile marshes of the Nile. Symbols of the god Thoth, the birds were mummified in greater numbers than any of the other animals interred at revered sites throughout Egypt (map, opposite).

into the streets to observe this occasion of national mourning. Wailing and tearing at their hair, they crowded the route to the catacomb now known as the Serapeum in the desert necropolis of Saqqara. In procession, priests, temple singers, and exalted officials delivered the mummy to the network of vaulted galleries carved into the bedrock of limestone. There, among the long corridors of previous burials, they interred the mummy in a massive wooden or granite sarcophagus. In later centuries, though, the sanctity of this place was violated as thieves pried off the sarcophagus lids and ransacked the mummies to find their precious ornaments. Sadly, not a single burial of the Apis bull has survived intact.

Different sacred animals were worshipped at their own cult centers—bulls at Armant and Heliopolis, fish at Esna, rams at Elephantine Island, crocodiles at Kom Ombo. Ikram believes the idea of such divine creatures was born at the dawn of Egyptian civilization, a time when heavier rainfall than today made the land green and bountiful. Surrounded by animals, people began to connect them with specific gods according to their habits.

Take crocodiles. They instinctively laid their

eggs above the impending high-water line of the Nile's annual flood, the pivotal event that watered and enriched fields and allowed Egypt to be born again year after year. "Crocodiles were magical," Ikram says, "because they had that ability to foretell."

The news of a good flood, or a bad one, was important to a land of farmers. And so, in time, crocodiles became symbols of Sobek, a water god of fertility, and a temple arose at Kom Ombo, one of the places in southern Egypt where the swelling flood was first observed every year. In that sacred space, near the riverbank where wild crocodiles lay sunning themselves, captive crocodiles led an indulged life and were buried with due ceremony after death.

THE MOST NUMEROUS mummies, buried by the millions as at Istabl Antar, were votive objects offered up during yearly festivals at the temples of animal cults. Like county fairs, these great gatherings enlivened religious centers up and down the Nile. Pilgrims arrived by the hundreds of thousands and set up camp. Music and dancing filled the processional route. Merchants sold food, drink, and souvenirs. Priests became salesmen, offering simply wrapped mummies

as well as more elaborate ones for people who could spend more—or thought they should. With incense swirling all around, the faithful ended their journey by delivering their chosen mummy to the temple with a prayer.

Some places were associated with just one god and its symbolic animal, but old, venerated sites such as Abydos have yielded whole menageries of votive mummies, each species a link to a particular god. At Abydos, the burial ground of Egypt's first rulers, excavations have uncovered ibis mummies likely representing Thoth, the god of wisdom and writing. Falcons probably evoked the sky-god Horus, protector of the living king. And dogs had ties to the jackal-headed Anubis, the guardian of the dead. By donating one of these mummies to the temple, a pilgrim could win favor with its god. "The creature was always whispering in the god's ear, saying, 'Here he is, here comes your devotee, be nice,'" explains Ikram.

Beginning in the 26th dynasty, in about 664 B.C., votive mummies became wildly popular. The country had just ousted its foreign rulers, and Egyptians were relieved to return to their own traditions. The mummy business boomed, employing legions of specialized workers. Animals had to be bred, cared for, dispatched, and mummified. Resins had to be imported, wrappings prepared, tombs dug.

Despite the lofty purpose of the product, corruption crept into the assembly line, and the occasional pilgrim ended up with something dodgy. "A fakery, a jiggery-pokery," Ikram says. Her x-rays have revealed a variety of ancient consumer rip-offs: a cheaper animal substituted for a rarer, more expensive one; bones or feathers in place of a whole animal; beautiful wrappings around nothing but mud. The more attractive the package, Ikram has discovered, the greater the chance of a scam.

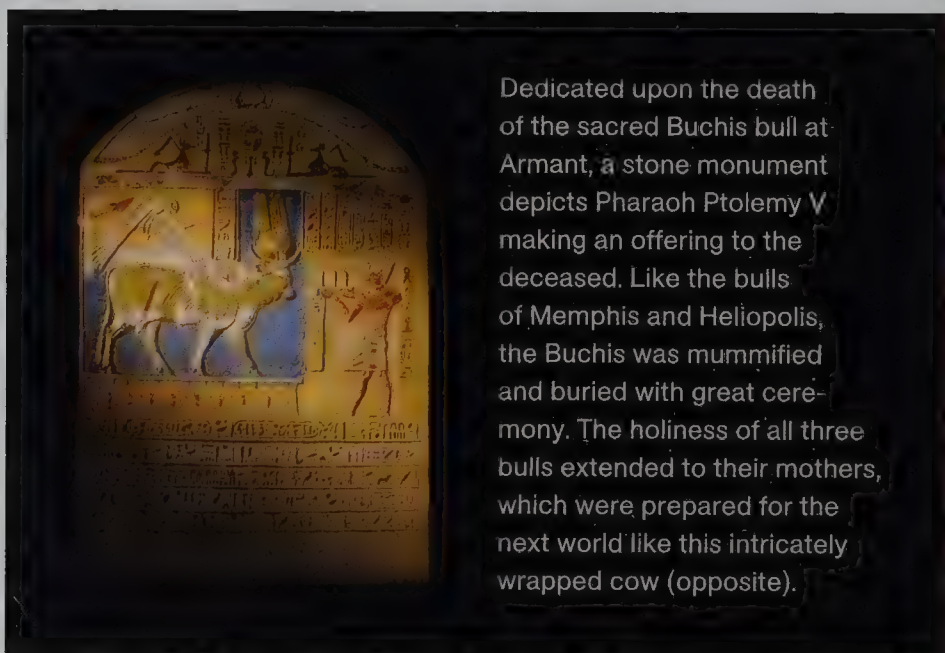
To find out how the ancient embalmers worked—a subject on which the ancient texts are silent or ambiguous—Ikram conducts experiments in mummification. For supplies she visits the labyrinth of Cairo's 14th-century suq. At a small shop just a block from the busy





The embalming house for the Apis bulls, sacred animals in the great city of Memphis, survives in ruins near the village of Mit Rahina. For 40 days the body of each bull lay in natron on a massive stone bed in a courtyard where the sun could help desiccate and disinfect it.





Dedicated upon the death of the sacred Buchis bull at Armant, a stone monument depicts Pharaoh Ptolemy V making an offering to the deceased. Like the bulls of Memphis and Heliopolis, the Buchis was mummified and buried with great ceremony. The holiness of all three bulls extended to their mothers, which were prepared for the next world like this intricately wrapped cow (opposite).

souvenir stands, a clerk uses an old brass balance scale to weigh out kilos of gray crystalline chunks. This is natron, a salt that absorbs moisture and fat and was the key drying agent used in mummification. It's still mined just southwest of the Nile Delta and is usually sold as a washing soda. At the herbalist around the corner, Ikram finds oils that will make dry, stiff bodies flexible again and resinous lumps of frankincense that will seal bandages when melted. No one sells the palm wine that ancient embalmers used to wash out internal cavities after evisceration, so Ikram substitutes locally made gin.

Her mummifications began with rabbits. They're a manageable size, and she could get them at the butcher. "Instead of making them stew bunnies, I gave them life for eternity," she says. Flopsy—Ikram names all her mummies—was buried whole in natron. The body didn't last two days. Gases built up, and it exploded. Thumper had better luck. His lungs, liver, stomach, and intestines were snipped out. He was then stuffed with natron and buried in more of the same. He survived.

Fluffy, the next candidate, helped explain an archaeological puzzle. The natron packed inside her absorbed so much fluid that it became

goopy, smelly, and disgusting. Ikram dug out the mess and replaced it with fresh natron tied in linen bags. These were simple to remove once they got soggy, explaining why similar bundles turn up in many embalming caches.

Peter Cottontail's treatment was entirely different. Instead of evisceration, he got a turpentine and cedar-oil enema before being placed in natron. Herodotus, the famed Greek historian, wrote about the procedure in the fifth century B.C., but scholars debate his reliability. In this case, the experiment proved him right. All Peter's innards dissolved except the heart—the one organ ancient Egyptians always left in place.

Like the animals mummified more than 3,000 years ago, Ikram's went to a happy afterlife. Once the lab work was done, she and her students followed protocol and wrapped each body in bandages printed with magical spells. Reciting prayers and burning incense, they laid the mummies to rest in a classroom cabinet, where they draw visitors—including me. As an offering, I sketch plump carrots and symbols to multiply the bunch by a thousand. Ikram assures me that the pictures have instantly become real in the hereafter, and her rabbits are twitching their noses with joy. □





Once swaddled as mummies, the remains of a dog and two bulls are displayed at the Agriculture Museum in Cairo. Without modern imaging technology, early researchers stripped such creatures to the bone to identify the species.







Lovingly preserved, a hunting dog whose bandages fell off long ago likely belonged to a pharaoh. As a royal pet, it "would have been fed nibbly bits and spoiled rotten," says Salima Ikram. When it died, it was interred in a specially prepared tomb in the Valley of the Kings.





Buried with the dog on the preceding pages, a baboon (opposite) harbors a secret that helps identify it as a pet: An x-ray revealed missing canine teeth, probably removed to keep the creature from nipping royal fingers. During mass baboon burials at Tuna el-Gebel (above), priests placed a votive animal in each niche. Thousands of such mummies have been found at the site, and many more likely lie in areas yet to be explored.

SHADOWLAND

POISED TO PLAY A PIVOTAL NEW ROLE IN THE

By Don Belt

Photographs by Ed Kashi



DAMASCUS VIEWED FROM ATOP MOUNT QASIYUN DURING A CELEBRATION TO MARK THE END OF RAMADAN.

MIDDLE EAST, **SYRIA** STRUGGLES TO ESCAPE ITS DARK PAST.





Now a tourist attraction, Aleppo's hilltop Citadel has seen a dozen empires rise and fall. Beginning in the 1950s, the government made plans to bulldoze the adjacent Old City, which has straddled



crossroads of trade for 4,500 years. A band of civic officials, architects, and benefactors fought back and finally, decades later, prevailed: In 1986, UNESCO named Aleppo a World Heritage site.



Clamoring for lost lands, Syrians mark Independence Day, April 17, with a visit to the border of the Golan Heights, territory captured by Israel in the Six Day War of 1967. The crowd uses bullhorns to



shout patriotic slogans—and exchange gossip—across the demilitarized zone to the Golan village of Majdal Shams, whose residents remain Syrian citizens despite living on Israeli-occupied land.

THERE'S A PASSAGE in *The Godfather* in which a young Michael Corleone, living abroad, realizes that with his older brother suddenly and violently deceased, he now stands anointed—doomed is more like it—to take over the Mafia empire his aging father has built from scratch. “Tell my father to get me home,” he says to his host, resigned to the role he is now fated to play. “Tell my father I wish to be his son.”

If there was a moment like that for Bashar al Assad, the current president of Syria, it came sometime after 7 a.m. on January 21, 1994, when the phone rang in his rented apartment in London. A tall, scholarly ophthalmologist, Bashar, then 28, was doing a residency at Western Eye Hospital, part of St. Mary's Hospital system in Britain. Answering the phone, he learned that his older brother, Basil, while racing to the Damascus airport in heavy fog that morning, had driven his Mercedes at high speed through a roundabout. Basil, a dashing and charismatic figure who'd been groomed to succeed their father as president, died instantly in the crash. And now he, Bashar, was being called home.

Fast-forward to June 2000 and the death of the father, Hafez al Assad, of heart failure at age 69. Shortly after the funeral, Bashar entered his father's office for only the second time in his life. He has a vivid memory of his first visit, at age seven, running excitedly to tell his father about his first French lesson. Bashar remembers seeing a big bottle of cologne on a cabinet next to his father's desk. He was amazed to find it still there 27 years later, practically untouched. That detail, the stale cologne, said a lot about Syria's closed and stagnant government, an old-fashioned dictatorship that Bashar, trained in healing the human eye, felt ill-equipped to lead.

“My father never talked to me about politics,” Bashar told me. “He was a very warm and caring father, but even after I came home in 1994, everything I learned about his decision-making came from reading the notes he made during meetings, or by talking to his colleagues.” One of those lessons was that, unlike performing eye surgery, running a country like Syria requires a

certain comfort with ambiguity. Bashar, an avid photographer, compares it with a black-and-white photograph. “There's never pure black or pure white, all bad or all good,” he said. “There are only shades of gray.”

Syria is an ancient place, shaped by thousands of years of trade and human migration. But if every nation is a photograph, a thousand shades of gray, then Syria, for all its antiquity, is actually a picture developing slowly before our eyes. It's the kind of place where you can sit in a crowded Damascus café listening to a 75-year-old storyteller in a fez conjure up the Crusades and the Ottoman Empire as if they were childhood memories, waving his sword around so wildly that the audience dives for cover—then stroll next door to the magnificent Omayyad Mosque, circa A.D. 715, and join street kids playing soccer on its doorstep, oblivious to the crowds of Iranian pilgrims pouring in for evening prayers or the families wandering by with ice cream. It's also a place where you can dine out with friends at a trendy café, and then, while waiting for a night bus, hear blood-chilling screams coming from a second-floor window of the Bab Touma police station. In the street, Syrians cast each other knowing glances, but no one says a word. Someone might be listening.

The Assad regime hasn't stayed in power for nearly 40 years by playing nice. It has survived a tough neighborhood—bordered by Iraq, Israel, Jordan, Lebanon, and Turkey—by a combination of guile and cozying up to more powerful countries, first the Soviet Union and now Iran. In a state of war with Israel since 1948, Syria provides material support to the Islamist groups of Hezbollah and Hamas; it's also determined



"Dr. Bashar," a U.K.-trained ophthalmologist, became president after the death of his father, Hafez al Assad, who ruled as a dictator for 30 years. Bashar al Assad inherited his father's iron fist, but he also has an eye for reform.

to reclaim the Golan Heights, a Syrian plateau captured by Israel in 1967. Relations with the United States, rarely good, turned particularly dire after the 2003 U.S. invasion of Iraq, when George W. Bush, citing Syria's opposition to the war and support for Iraqi insurgents, threatened regime change in Damascus and demonized Syria's young president as a Middle Eastern prince of darkness.

It's been nearly a decade since Bashar took office, and it's fair to ask what, if anything, has changed. It's also a good time to take stock, as Syria—responding to overtures from a new U.S. administration hungry for success in the Middle East—seems poised to resume a pivotal role in regional affairs. Henry Kissinger famously said you can't make war without Egypt or peace without Syria, and he's probably right. Like it or not, the road to Middle East peace runs right through Damascus. Yet even Bashar acknowledges that it

will be hard for Syria to move forward without tending to its crippling internal disrepair.

Outside the ancient Hamadiya market in Damascus, a photograph of Hafez al Assad as tall as a three-story building once stood. Marked by a high forehead and poker player's eyes, the president's giant head peered out over his traffic-choked capital of four million people, as it did from billboards and posters all over Syria. Modeled on the totalitarian cults of the Soviet imperium, this Big Brother iconography always gave Syria the feel of being sealed in amber, trapped in an era when dictators were really dictators, the days of Stalin and Mao. This is the Syria that Hafez left behind.

In its place today, flanked by the city's

Don Belt is the magazine's senior editor for foreign affairs. He and photographer Ed Kashi reported on the plight of Arab Christians in the June 2009 issue.

**IT WILL TAKE MORE THAN
A SMILE AND A SLOGAN
TO REINVENT HIS COUNTRY,
AND BASHAR KNOWS IT.**

Roman-era walls, is a large white billboard with a photograph of Syria's first postmodern president, waving. Bashar is shown with a buoyant grin on his catlike face, squinting over his whiskers into a bright sun. "I believe in Syria," the billboard says reassuringly. But it will take more than a smile and a slogan to reinvent his country, and he knows it. "What Syria needs now," Bashar told me, "is a change in the mentality."

THE HOME VILLAGE of the Assad family, Al Qardahah, sits on a mountainside facing west, sheltered and aloof as hill towns often are, yet so close to the Mediterranean that on a clear day you can see the fishing boats of Latakia, Syria's largest port, and the seabirds circling like confetti in the western sky. A modern, four-lane expressway rises like a ramp from the coast and delivers supplicants to the remote mountain village, where the streets are paved, houses upscale, and off-duty regime officials—large men in their 50s and 60s who carry themselves like Mafia dons on vacation—pad around town in their pajamas.

Hundreds of years ago Al Qardahah was an enclave of destitute Shiites who followed the Prophet's son-in-law and successor, Ali, so fervently that centuries before they'd been declared heretics by other Muslims and driven into the mountains of northwest Syria, where they came to be known as Alawis. Then in 1939, one of their own—a whip-smart, nine-year-old boy named Hafez—was sent down the mountain to get an education. He lived in Latakia while attending schools run by the French, who had taken over this part of the Ottoman Empire after World War I, in the great carving up of historic Syria (which included present-day

Israel, Palestinian territories, Jordan, Lebanon, western Iraq, and southern Turkey) that Britain and France had plotted in the Sykes-Picot Agreement of 1916.

Quiet and tall for his age, Hafez was driven to succeed and ultimately to rule. After Syria gained its independence from France in 1946, he joined the Baath Party, a secular Arab nationalist movement that would seize control of Syria in 1963. Hafez rose through the ranks of the air force and was eventually appointed defense minister. From that position, in 1970, he mounted a bloodless coup with a trusted coterie of military officers, many of them fellow Alawis. Since then, followers of this tiny Shiite sect have managed to hang on to power in this complex, ethnically volatile nation of 20 million people, 76 percent of whom are Sunni—a scenario that one diplomat likens to the Beverly Hillbillies taking charge of California.

Hafez al Assad survived by becoming a world-class manipulator of geopolitical events, playing the weak hand he was dealt so cleverly that Bill Clinton called him the smartest Middle Eastern leader he'd ever met. Inside Syria, Hafez was a master at downplaying the country's potentially explosive religious identities and building an adamantly secular regime. He discouraged the use of the term Alawi in public and changed the name of his home region to the Western mountains; it is still considered impolite to ask about a Syrian's religion today. He also went out of his way to protect other religious minorities—Christians, Ismailis, Druze—because he needed them as a counterweight to the Sunnis.

Hafez was ruthless toward his enemies, especially the Syrian Muslim Brotherhood, a Sunni Islamist movement eager to remove the apostate Alawis from power and make Syria an Islamic state. To counter them, he built an elaborate internal security apparatus modeled after the communist police states of Eastern Europe. When the Brotherhood launched a series of attacks in the late 1970s and early 1980s, Hafez sent his air force to bomb densely populated neighborhoods in the group's stronghold in Hama. His army

MINORITY RULE

Though the population is mostly Sunni Muslim, Syria's ruling family are members of the Alawi sect. An influx of Palestinian and Iraqi refugees—a mix of Christians and Muslims—has added 1.5 million more people to a country of 20 million.

Religions

(percent of Syria's population)

- Sunni Muslim (76%)
- Alawi Muslim (12%)
- Druze Muslim (3%)
- Christian (7%)
- Shiite Muslim, Ismaili Muslim, Yezidi (2%)
- Sparsely populated or uninhabited

Ethnic groups

- Arab 90%
- Kurd 9%
- Armenian and other 1%



NGM MAPS. SOURCE: M. R. IZADY

bulldozed the smoking remains. Between 10,000 and 40,000 people were killed, and thousands more were jailed, tortured, and left to languish in prison. Despite criticism from human rights organizations, the regime soon unleashed its internal police on all political opponents.

When Hafez al Assad died in 2000, his body was returned to Al Qardahah and placed near that of his firstborn son, Basil, whose adrenaline-charged exploits on horseback, in uniform, and behind the wheel set him apart from his studious younger brother, a soft-spoken health nut whose musical taste runs to Yanni and the Electric Light Orchestra. Yet any suggestion that Bashar is a pushover is an illusion, says Ryan Crocker, who served as U.S. Ambassador in Damascus during the transition from father to son. "Bashar is so personable that it's easy to underestimate him," Crocker says. "But rest assured: He is his father's son."

A YOUNG MAN in an imitation black leather jacket was drawing in my notebook, launching

a sailboat on a choppy sea with careful strokes of a blue pen. We were at a café overlooking the stony hills of northern Syria, watching cloud shadows play across a landscape of red soil and silver-green olive trees. Freedom, the man was saying. That's what we need.

"I'm not talking about political freedom," he said, glancing over his shoulder to be sure there were no *mukhabarat*, or secret police, about. "I mean the freedom to do things," he went on, "without getting strangled in rope by bureaucrats. In Syria, for guys like me, there's no incentive to try anything new, to create something. No way. You could never get approval from the government, or even the permits to think about it. Here it all comes down to who you know, what clan or village you're from, how much Vitamin Wow is in your pocket."

"Vitamin Wow?" I said, recalling that there is an Arabic letter pronounced "wow."

"Wasta!" he said, laughing. Money! Bribes!

"Where is your sailboat going?" I asked, nodding at his sketch.

"Nowhere," he said, grinning. "I've got no Vitamin Wow!"

Shortly after Bashar returned from London, he diagnosed Syria as suffering from an overdose of Vitamin Wow. After taking office in 2000, he launched a tough anticorruption campaign, firing a number of ministers and bureaucrats and vowing to replace old, wasta-loving ways with the "new mentality" he was seeking to instill. Swept up in the spirit of reform, he went on to release hundreds of political prisoners and eased the restrictions on political dissent—a so-called Damascus Spring that quickly spread from living rooms to a growing subculture of Internet cafés. It was Bashar himself who had made this last trend possible, working with like-minded technocrats to computerize Syria even before he became president. Over the objections of the country's powerful military-intelligence complex, Bashar had persuaded his father to connect Syria to the World Wide Web in 1998.

He also took steps to reboot Syria's stagnant economy. "Forty years of socialism—this is what we're up against," said Abdallah Dardari, 46, a London-educated economist who serves as deputy prime minister for economic affairs. Bashar has recruited Syria's best and brightest expatriates to return home. The new team has privatized the banking system, created duty-free industrial parks, and opened a Damascus stock exchange to encourage more of the private and foreign investment that has quickened the pulse of the capital and launched dozens of upscale nightclubs and restaurants.

"My job is to deliver for the people of Syria," said Bashar, who is known for occasionally dropping by a restaurant, leaving the bodyguards outside, to share a meal with other diners. In his push to modernize, Bashar's most potent ally is his wife, the former Asma al-Akhras, a stylish, Western-educated business executive who has launched a number of government-sponsored programs for literacy and economic empowerment. Daughter of a prominent Syrian heart specialist, Asma was born and raised in London. She and Bashar have three children, whom they're fond of taking on picnics and bicycle





Enrollment at Al Sit school for girls in Damascus has doubled with the influx of some 1.4 million Iraqi refugees. Though welcoming, Syrian schools are busy with struggles of their own: modernizing teaching techniques and textbooks.



a group of young technocrats who connected Syrians to the Internet in 1998, yet as president he has cracked down on Web use. His country skews young, with more than half the population under age 24.

Drilling on pain-free plastic, dental students attend Kalamoun, Syria's first private university, built to compete with public schools where training is reserved for champion test-takers and the politically connected. Syria's stock exchange (bottom) opened this past March, another step toward privatization.



rides in the hills around the capital—a marked contrast to Hafez al Assad, who was rarely seen in public. “You only know what people need if you come in contact with them,” Bashar said. “We refuse to live inside a bubble. I think that’s why people trust us.”

FOR MORE THAN 4,000 YEARS, the city of Aleppo in northern Syria has been a crossroads for trade moving along the Fertile Crescent from Mesopotamia to the Mediterranean. Guarded by a towering hilltop Citadel, Aleppo’s 900-acre Old City has remained essentially intact since the Middle Ages. Today, entering its covered suq, the largest in the Arab world, is like stepping across some cobblestone threshold into the 15th century—a medieval mosh pit of shopkeepers, food vendors, gold merchants, donkey carts, craftsmen, trinket peddlers, beggars, and hustlers of all stripes, moving in a great colorful clanking parade of goat bells and sandaled feet. If Aleppo bureaucrats had gotten their way, much of this would be gone.

During the 1950s, urban planners in Aleppo began implementing a modern development plan, dissecting the Old City with wide, Western-style streets. In 1977, local residents, led by an Old City architect named Adli Qudsi, fought back and eventually got the government to change its plan. Today the Old City has been preserved and its infrastructure overhauled, with funds from both government and philanthropic sources. Once considered a crumbling relic, old Aleppo is now cited by Bashar as a prime example of the new mentality he’s seeking, a model for how Syria’s past, its greatest asset, can be retooled and made into a future.

“Syria has been a trading nation for millennia, so what we’re trying to do is return the country to its entrepreneurial roots,” said Dardari. “But it’s not going to be easy: 25 percent of the Syrian workforce still draws a government paycheck. We’ve inherited an economy that runs on patronage and government money, and we can’t keep it up.”

To see what Dardari and the modernizers are up against, I toured a government cotton-processing

**WHEN I ASKED IF THE
FACTORY MADE A PROFIT, HE
LOOKED AT ME AS IF I WERE
SPEAKING IN TONGUES.**

plant in Aleppo reminiscent of factories in the Soviet Union, vast and crumbling monuments to rusty machinery. The plant manager rambled on like a good apparatchik about the aging factory’s production figures and impeccable safety record—unaware that a group of workers had just told me about the lost fingers, crushed feet, and lung damage they had suffered. When I asked if the factory made a profit, he looked at me as if I were speaking in tongues.

By allowing private investment in state-run industries, starting with cement and oil processing, Bashar and his reformers hope to modernize their operations and run them more efficiently. Many jobs have been lost in the process, and prices, no longer subsidized, have soared. But so many Syrians depend on government-supplied incomes from the cotton industry—a primary source of export revenue—that it remains mostly state run.

In many respects, the Syria that Bashar inherited bears all the signs of an antique enterprise, ready for the wrecking ball. Built by the Syrian Baath Party in the 1960s, the system of state enterprises and government jobs raised living standards and brought education and health care to rural villages, but its foundation resembles the corrupt and moribund Eastern-bloc socialism that collapsed under its own weight in the early 1990s. The Syrian bureaucracy is even older, having been erected from the fallen timbers of Ottoman and French colonial rule.

Education reform is also on Bashar’s drawing board, and not a moment too soon. Syrian schoolchildren are taught by rote memorization from aging textbooks, and judged, even at the university level, by the number of facts they know. In Damascus, once revered as an intellectual



Barefoot farmers in the fields near Idlib stomp 300 pounds of cotton into each burlap bag, which is then muscled onto a truck and hauled to collection centers. Most cotton—a primary export and a vital



source of jobs—is grown on private farms but ginned at public mills, a remnant of the state-run industries that once dominated Syria’s economy, modeled on the socialism of the Soviet bloc.

**LIVING IN SYRIA IS LIKE
WALKING SIDEWAYS WITH A
LADDER, HAVING TO WATCH
EVERY MOVE YOU MAKE.**

capital of the eastern world, it's hard to find a bookstore that isn't stocked with communist-era treatises penned by Baath Party ideologues.

"My 11-year-old daughter is so confused," said Dardari. "She hears from me at home about free markets and the way the world works, and then she goes to school and learns from textbooks written in the 1970s that preach Marxism and the triumph of the proletariat. She comes home with this look on her face and says, 'Daddy, I feel like a Ping-Pong ball!'"

WHEN A SON GOES into the family business, the old way of doing things can be very hard to change. And even though the eldest son, Basil, was considered more like his father, Bashar has ended up following in his footsteps—in more ways than one. A year into his presidency, planes hit the World Trade Center in New York City, and suddenly the threat to secular, "non-Muslim" regimes like Syria's from al Qaeda and its cousins in the Muslim Brotherhood appeared stronger than ever. The U.S. invasion of Iraq—and subsequent saber rattling toward Damascus—inflamed Syria's Islamists even further, while swamping the country with some 1.4 million Iraqi refugees, most of whom never returned home. Some believe that Bashar, in a move reminiscent of his father, diverted the widespread rage in Syria away from his vulnerable regime toward the Americans across the border in Iraq, allowing jihadists to use Syria as a staging area and transit point.

Even before 9/11, Bashar had backtracked on political reform and freedom of expression. His anticorruption drive had stalled, undermined by the shady business dealings of his own extended family. Investigations into the 2005 assassination

of former Lebanese Prime Minister Rafiq Hariri in Beirut led to Syria's doorstep; shortly thereafter Bashar rearrested many of the political prisoners he'd released just a few years earlier. And last year, in an ironic twist for a self-confessed computer nerd who brought the Internet to Syria, Bashar's government banned a long list of websites, ranging from Arabic news sites to YouTube and Facebook. In all this, some see Bashar as the victim of reactionary elements within the regime—the youthful idealist dragged down by forces he is powerless to resist. Others see a young godfather learning to flex his muscles.

Bashar blames the U.S. invasion of Iraq for pushing the region, and Syria, into a dark corner and defends his tough internal security measures as vital weapons in the struggle to survive. Whether he's talking about the survival of Syria, or his regime, is unclear. "We're in a state of war with Israel," he said. "We've had conflicts with the Muslim Brotherhood since the 1950s. But now we have a much worse danger from al Qaeda. Al Qaeda is a state of mind. It's a CD, it's a booklet. And it's very hard to detect. This is why we need a strong internal security."

Members of the opposition, nearly all of them underground or in jail, don't buy that argument, having heard it used for 30 years to smother any spark of dissent. While acknowledging that today's repression is administered with a lighter touch, the activists I talked to consider the differences between Bashar's regime and his father's to be cosmetic. "Bashar seems like a pretty nice guy, but the government is more than one person," said a young human rights activist I met secretly with in a tiny, book-lined apartment on the outskirts of the capital. He'd been interrogated a half dozen times by various agencies of state security. "Living here is something like a phobia," he went on, smoking a cigarette, dark circles under his eyes. "You always feel like someone's watching. You look around and there's no one there. So you think, I shouldn't have this feeling, but I do. I must be crazy. This is what they want."

Whatever its purpose, Syria's shadow of fear, the cloud that blocks its sun, is pervasive. To

Feted for her first Communion, Marla Baqleh of Jaramanah immortalizes a tableful of pastries. Christians and other religious minorities are vigorously protected by the Assad regime, itself drawn from a tiny Shiite sect. In a nearby hammam, fathers and sons enjoy the intimate ancient rituals of the baths.





In varied states of devotion, pilgrims worship at the Sayida Zainab shrine in Damascus. This is the traditional resting place of Zainab, granddaughter of the Prophet Muhammad and daughter of Ali, Islam's



fourth caliph, who is revered by Shiites. In crowded neighborhoods around the mosque, tens of thousands of Iraqi refugees mingle with visitors from Iran, who make up a sizable portion of Syria's tourists.



School's out in the Western mountains, home to the Alawi clans—and the ruling family of Syria. Their trademark: the watchful gaze of late strongman Hafez al Assad (background, at center), his image flanked by portraits of his sons.



protect my sources for this article, I've left a number of people unnamed, fearing that they'd be arrested once it's published. An academician I met in Aleppo, for example, was harshly interrogated after attending a conference where Israeli scientists were present. After trying to browbeat him into informing on others, the interrogators let him go with a warning not to breathe a word or his file would be reopened. In Idlib, an Islamic fundamentalist hotbed south of Aleppo, a merchant compared living in Syria, with its internal security apparatus, to "walking sideways with a ladder, always having to think ahead and watch every little move you make."

ONE MORNING in Damascus, I was talking to a group of day laborers in a park, scruffy guys in their late teens and early twenties who were looking for work. Most were from southern Syria around Dara, and we were debating what kind of city Dara is. They were bad-mouthing it as a dry and dirty hellhole; I was defending it, having passed through a number of times on my way to Jordan. While we were bantering, a bullish, middle-aged man in a green polo shirt and wraparound sunglasses drifted over and listened in. As the workers became aware of him, our discussion murmured to a halt.

"Dara is a truly great city," the newcomer finally said, with an air of steely finality. The others moved away, suddenly afraid of this man. To see what he would do, I told him I was scheduled to see the president and asked if he'd like me to convey a message. He stared at me for a long moment, then went over and sat on a bench, scribbling in a notebook. I figured he was writing a report on me, or perhaps issuing some kind of ticket. A few minutes later, he was back.

"Please pass this to the president," he said, handing me a slip of paper folded so many times it was the size of a spitball. Then he turned and walked away. On it he had scrawled his name and phone number and a message in rough Arabic: "Salute, Dr. President Bashar, the respected. This paper is from a national Syrian young man from Al Hasakah who needs very much a job in the field of public office, and thank you." □



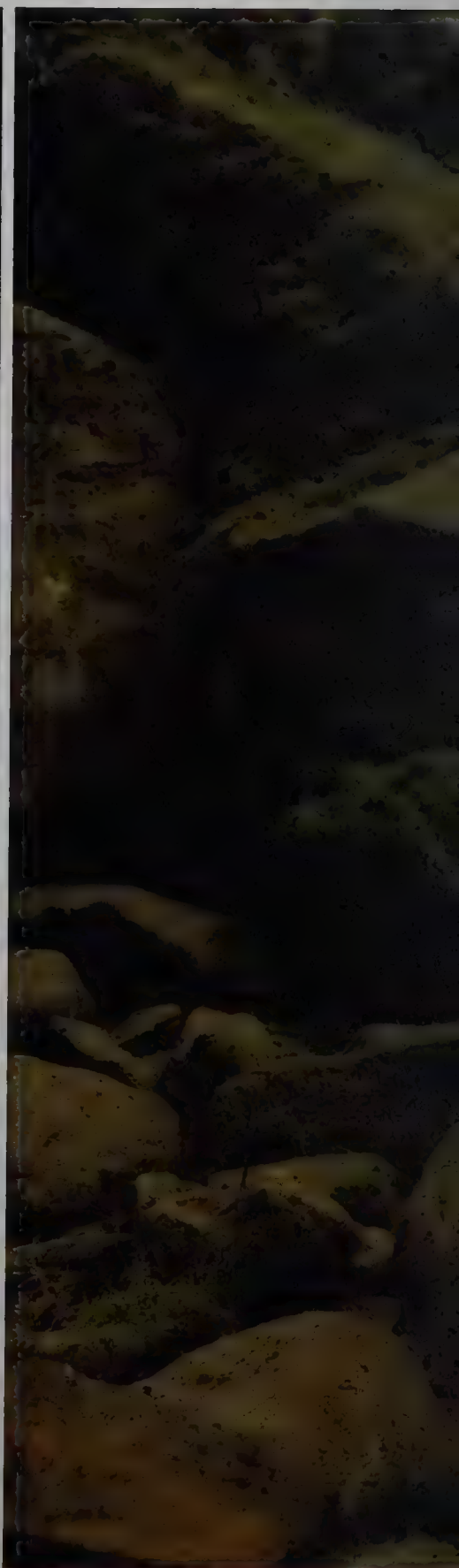
BLAZE OF BLUE

KINGFISHERS

Its perch serving as lookout and diving board, a kingfisher waits above the still waters of an English river, which reflects trees and sky. This flashy hunter can dive and return with a fish in two seconds.



An azure blur, a kingfisher plummets toward the water, reaching speeds of more than 25 miles an hour. The bird's aim is so unerring that even though a protective translucent membrane veils its eyes underwater (right), it can confidently catch fish to depths of two feet.





In a prey's-eye view, an adult female snaps up a stickleback, a small spiny fish, from just beneath the water's surface. Beak color gives away a kingfisher's gender: Males show mostly black, while females have an orange lower mandible that matches their feet.





A FLASH OF ELECTRIC BLUE—that’s as intimately as most people will ever know the common kingfisher. But it suffices. ■ “Everyone in England who has ever seen one will remember where they saw it,” says photographer and kingfisher thrall Charlie Hamilton James. “I saw my first one when I was a boy. I’ve been completely obsessed ever since.” For a few years he traipsed empty-handed after the bird near Bristol, in

southwest England. Later, to justify the hours spent on the gloomy riverbanks that kingfishers haunt, he took along a camera. That was 20 years ago.

Alcedo atthis (also known as the Eurasian, European, or river kingfisher) has inspired many an obsession. In the world’s temperate zones, where drab plumage is the norm, this kingfisher, unlike its North American cousins, bedazzles. Slicing the air like a turquoise missile, it is impossible to disregard.

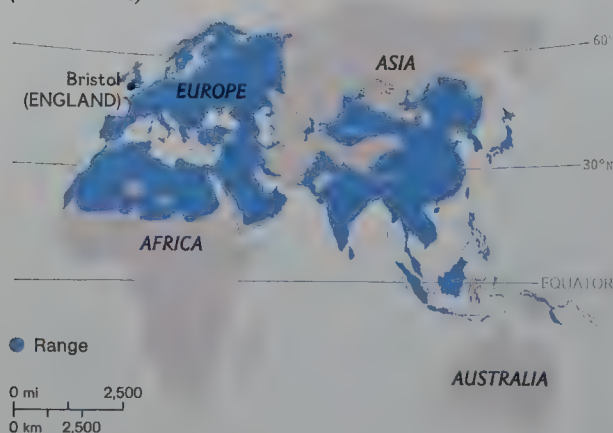
The yellow, red, orange, and brown birds of the world assume their hues because of a pigment embedded in the keratin matrix of feathers. But blue feathers result from refraction, a prism-style splitting of light inside a feather. Under a microscope each long kingfisher barb, finer than a human hair, glitters with shades of the Caribbean. Tiny structures in the feathers choreograph incoming light, reflecting sapphire in one direction, emerald in another.

Alas, beauty can be a curse. At times, kingfisher feathers have achieved the status of gemstones, silk, and spices. A third-century Chinese text describing Western cultures included a list of treasures that might be extracted from the Roman Empire: ivory, gold, carnelian, pearls, kingfisher feathers. Over the course of 2,500 years, the Chinese fashion industry plucked an inconceivable number of birds from the forests of Asia. In an art form called *tian tsui*, or dotting with kingfishers, craftsmen applied the shimmering feathers to jewelry, fans, privacy screens, and landscape panels. Entire quilts were reportedly transformed into blue-green seascapes. Korean royalty shared the passion, which finally faded in the early 1900s.

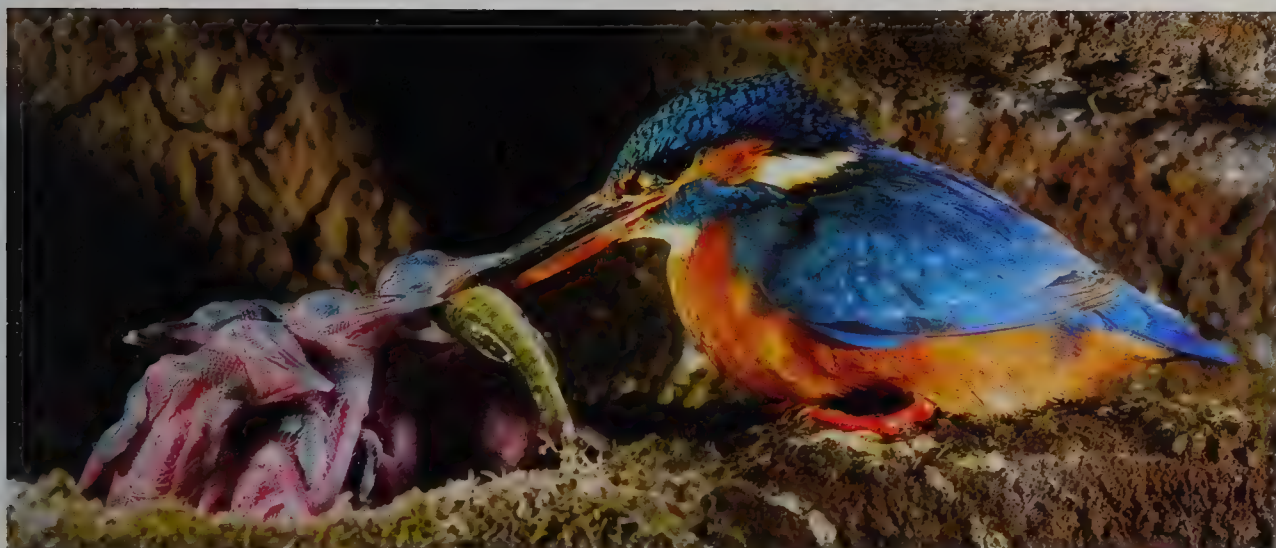
Fortunately, these days the little spitfire’s rarity is an illusion. The kingfisher isn’t shy; it simply exploits an environment most people (with the exception of Hamilton James and his sort) avoid. The ideal riverbank is crumbly enough for the birds to excavate a nesting burrow with their beaks. The nest should be sufficiently high to ride out occasional floods and sufficiently low to thwart foxes, snakes, and other raiders trying to penetrate from above.

Solitary most of the year, each individual strives to protect enough real estate to guarantee steady fishing and a good nest site. “These tiny little birds have got to hold down a whole mile of river,” explains Hamilton James. Neither male nor female will hesitate in the defense of this life-sustaining territory. At just an ounce and a half, a kingfisher is a force to be reckoned with. “They’re very loud, and they tell everyone they’re coming,” says Hamilton James. “I suppose they are quite arrogant.”

COMMON KINGFISHER RANGE
(*Alcedo atthis*)



NGM MAPS
SOURCE: WORLD WILDLIFE FUND



In a riverbank burrow a mother feeds one of her nine-day-old chicks a small fish, which it will swallow whole.

Disputes begin with high-speed chases and the occasional beak jab. If aerial jousting doesn't settle the argument, things may turn deadly. At the river's edge two birds will lock beaks and attempt to force each other underwater.

Breeding season requires a pause in the usual hostilities between sexes. The male's opening move is direct: He hurtles after his former foe, whistling urgently. If she tolerates his company, he will ply her with fresh fish, directing them headfirst into her beak. On occasions when a truce is struck between neighbors, the pair will merge territories—temporarily. From their joint holdings they'll either select an old nest for reuse or start anew. Chiseling a two-foot tunnel can take ten days of hard labor for the pair.

After three weeks of brooding, the eggs hatch. Hardly fastidious homemakers, the birds raise their nestlings in the dark on a layer of tiny fish bones regurgitated as pellets, then shattered with a perfunctory peck. (Hamilton James has watched this behavior from a subterranean observatory adjoining a nest.) Both parents fish in earnest. The kingfisher is an ambush hunter, perching over a river until a small fish flicks into range. It can plummet, strike, and wing back to its perch in the space of two blurry seconds. It thumps the catch against the branch to stun it—a lesson some young birds learn only after

swallowing a stickleback that erects its dorsal spine on the way down. For the three or four weeks that chicks are in the nest, the adults may bring home 50 to 70 fish a day, and that messy layer of fish bones builds up.

What kingfishers lack in fine manners they make up for in fecundity. Many bird species will raise a second brood, but kingfishers, averaging six or seven eggs per clutch, often raise a third. One pair was observed raising a fourth.

Zealous reproduction helps the species thrive. Throughout its range, the kingfisher's status is stable enough that very few ornithologists pay it much heed. The handful of *Alcedo atthis* scholars report that it is one of the wild animals that don't mind rubbing shoulders with humans—good news in an increasingly urban world.

Hamilton James observes that his local birds are always willing to annex a backyard goldfish pond. And Japanese ornithologist Satoe Kasahara says that lately kingfishers have snatched fish from urban ponds in her country. Across the kingfisher's range, wherever rivers are healthy, fish will swim. And where the fish go, the flashy little bird with the sassy whistle is likely to follow. □

Hannah Holmes's most recent book is *The Well-Dressed Ape: A Natural History of Myself*. Charlie Hamilton James is equally compelled by otters and kingfishers.

"The Kingfisher rises out of the black wave like a blue flower," wrote poet Mary Oliver, paying tribute to the dashing river bird on its feeding rounds. Light scatters prismatically in microscopic feather structures to create the kingfisher's brilliant blue.











LIVING ON A RAZOR'S EDGE

MADAGASCAR'S LABYRINTH OF STONE





A city of limestone towers (preceding pages) rises in western Madagascar, its neighborhoods cut by canyons and cellared by caves (right). Unexplored passages shelter some of the island's—and the world's—strangest species, from the ghostly Decken's sifaka, a lemur, to a host of reptiles, insects, and plants.





Climber John Benson weaves through skin-ripping pinnacles. In Malagasy, the formations are called *tsingy*, meaning “where one cannot walk barefoot.” The terrain resists intrusions from hunters, hungry cattle, and wildfires.

BY NEIL SHEA

PHOTOGRAPHS BY STEPHEN ALVAREZ



The lizard moved in frightened rhythms across the sun-blasted stone. A few quick steps, a turn of its boxy head. Then the stillness, the absolute zero, of a creature that sensed it was being hunted. All around, jagged spires and flutes rose like the towers of some Gothic cathedral, silent and empty. From the canyons below, a parrot flew squawking, breaking the trance. The lizard launched. Hery Rakotondravony's arm fired out. Moments later the young herpetologist uncurled his fingers. "I think this is a new species."

In the few days we'd spent in Madagascar's Tsingy de Bemaraha national park and reserve, it was the second or third time he'd said this. On an island famous for its biodiversity (90 percent of the species here are endemic, found nowhere else on Earth), the 600-square-mile protected area is an island unto itself, a kind of biofortress, rugged, largely unexplored, and made nearly impenetrable by the massive limestone formation—the *tsingy*—running through it.

The great block of Jurassic stone has dissolved into a labyrinth of knife-edged towers, slot canyons, and wet caves that ward off humans while harboring other animals and plants. New species are frequently described from the isolated habitats within—a previously unknown coffee plant in 1996, a minuscule lemur in 2000, a bat in 2005, a frog two years later. Even larger animals have been found relatively recently, including a long-legged lemur discovered in 1990 but named, somewhat whimsically, only in 2005 after British comedian and conservation advocate John Cleese.

Steven Goodman, a biologist with the Field Museum in Chicago who has lived and worked in Madagascar for 20 years, describes the region

Contributing Writer Neil Shea's winter adventure on Mount Washington appeared in February. Stephen Alvarez photographed caves for the June issue.





Sunlight rakes the heights of the tsingy, where any rainfall is quickly shed. The arid upper reaches favor mobile creatures such as dragonflies (here in a cooling posture) as well as spiny, drought-tolerant *Pachypodium* plants (above).

as “a refuge within paradise,” a place where a kind of biology more familiar a century ago can still be practiced and where simply walking around might put you face-to-face with a creature never seen before.

“You can move between valleys and find different things,” Goodman said. “The tsingy formations of Madagascar are one of the places on Earth that hold extraordinary biological treasures. You just have to go in and look around.”

Going in is the hard part. In March, at the end of the rainy season, just before the leaves browned and fell and winter dried the forest’s thin streams, photographer Stephen Alvarez and I traveled into the park. Rakotondravony had agreed to guide us. It was his fourth trip to the Tsingy de Bemaraha; he is one of a handful of scientists who have gone there more than once.

We arrived in the capital, Antananarivo, just after the president had been overthrown in a coup. Violent protests flared every few days. Near the main square, soldiers lazed in

transport trucks smoking and sending text messages, while on the university campus, students rallied beneath white banners, only to be driven back brutally. Tourism, a mainstay of the economy, had nearly collapsed. We left the city wondering if we’d be stopped. But soon, in the countryside, signs of the coup receded, the weight of it felt only at police checkpoints, where men in sandals cradled old AK-47s and asked where we were going.

It took nearly five days to reach the tsingy. Three days out, the route deteriorated into a deeply rutted dirt track that plunged through troughs of dark mud. Ferries carried us across rivers red with soil washed away in the aftermath of deforestation upstream. Villages shrank, cars vanished, the forest gradually thickened. Every few miles Rakotondravony leaped from our truck and ran into the bush. He’d return hauling a large snake or some unhappy lizard.

From a trailhead (Continued on page 104)

200 MILLION YEARS AGO
DEPOSITED

A bed of unusually pure limestone more than a thousand feet deep was deposited in a Jurassic lagoon.

UPLIFTED

Tectonic shifts slowly elevated the limestone formation, further exposed as sea levels fell during ice ages.

1.8 MILLION YEARS AGO
DISSOLVING

Caves formed where groundwater dissolved the stone along fracture lines created by the tectonic uplift.

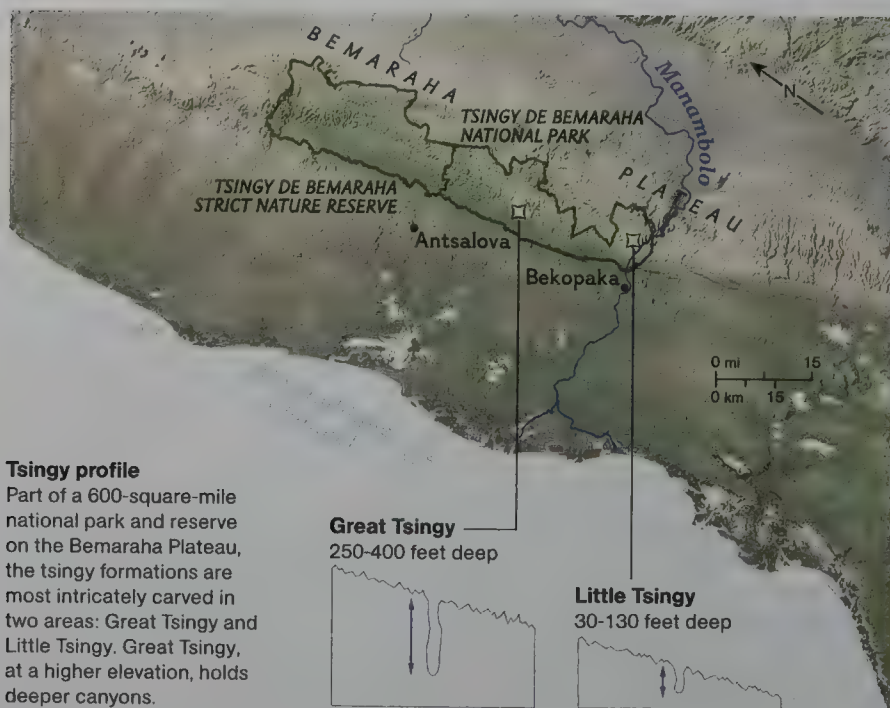
EXPANDING

The fluctuating water table scoured and enlarged the caves. Rain drilled down from the surface.

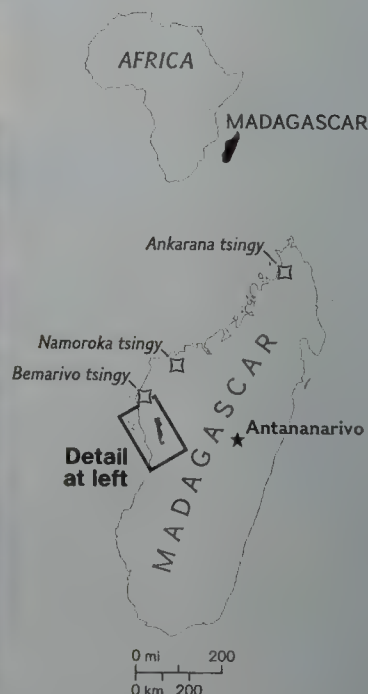


CARVING A JAGGED MAZE

The razor-backed canyons of the Tsingy de Bemaraha formed largely beneath the surface as deep, narrow caves. While monsoon rains chiseled the top of an expansive limestone deposit, subterranean groundwater dissolved the stone along a grid of fracture lines. When cave roofs collapsed and the water table fell, a labyrinth of canyons, called grikes, emerged, creating what geologist Márton Veress calls a “truly outrageous landscape.”



Tsingy profile
 Part of a 600-square-mile national park and reserve on the Bemaraha Plateau, the tsingy formations are most intricately carved in two areas: Great Tsingy and Little Tsingy. Great Tsingy, at a higher elevation, holds deeper canyons.

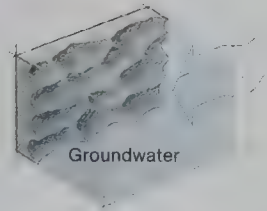


TODAY

OPEN CANYONS

Canyons were revealed as cave ceilings tumbled and the water table fell. Today groundwater still shapes new caves and other features.

Scalloped surfaces of the canyon walls show that they were cut by sediment-laden groundwater rather than rain.



Natural bridge formed by fallen boulder

Pinnacles

Natural bridge



Bottom channel

Notches

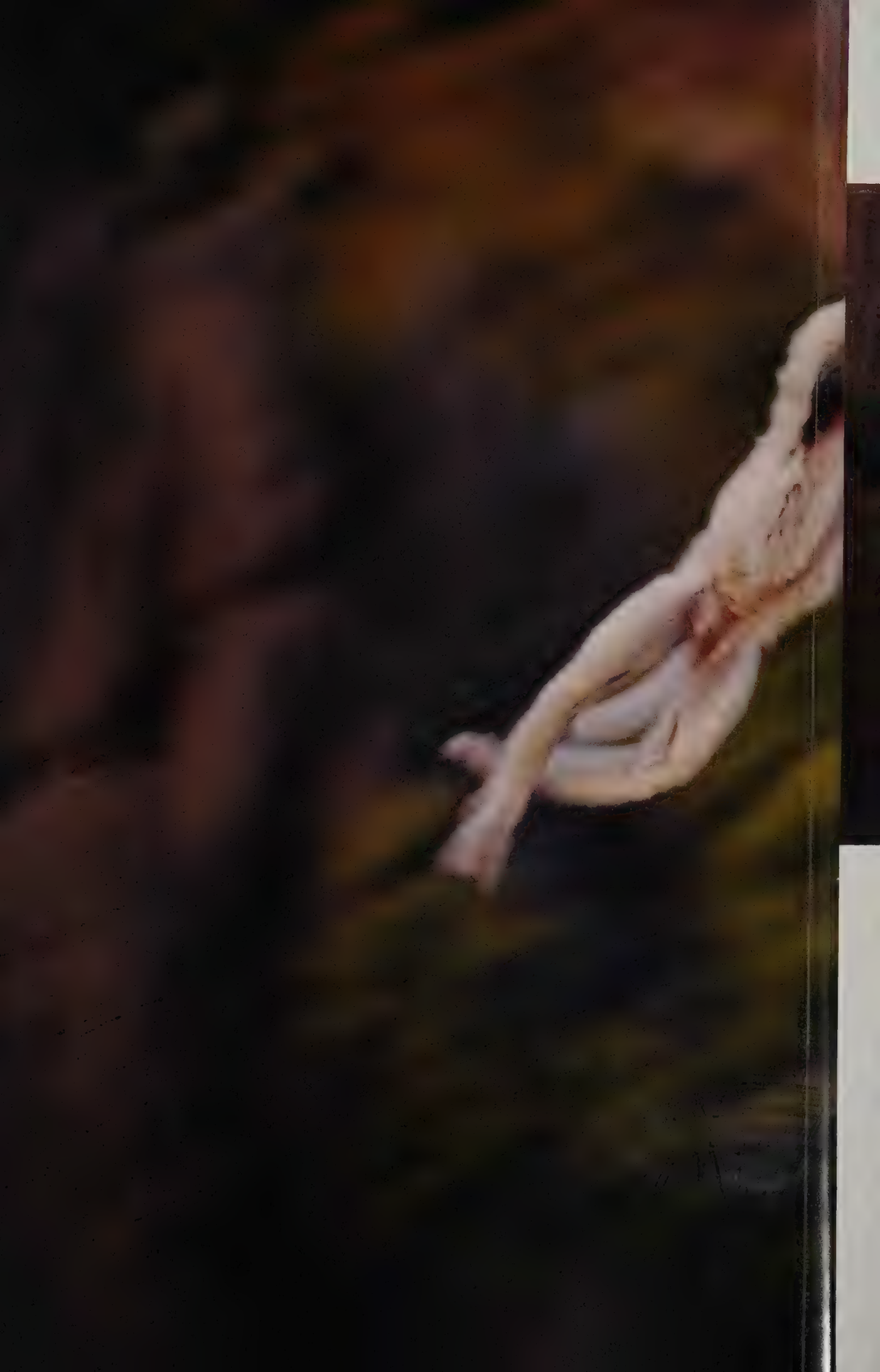
Grike

Roundabout cave













Fearless acrobat, a Decken's sifaka leaps a chasm a hundred feet deep to land on a splinter of stone (above). Troops of these primates, found only in western Madagascar, cruise the tops of the tsingy searching for food and evading predators. Like other lemurs, they probably live in small family groups. Little is known about their behavior, but evolution has equipped them with thick pads on hands and feet, helping them navigate their serrated home (preceding pages).

(Continued from page 95) near a small village, we hiked into the forest. After several months of rain, the prolonged dry period was beginning, when many creatures estivate, waiting for the wet to return. We pitched tents near a clear stream, with rust-colored crabs flitting through the shallows. Our kitchen was set beneath an overhang in a cliff that rose through the canopy and, far above, split and cracked into the needles and fins and towers that give the place its name.

IN MALAGASY TSINGY MEANS “where one cannot walk barefoot,” but we found that the landscape demanded much more than sturdy shoes. In several spots we tried exploring using rock-climbing gear. The tsingy chewed equipment and flesh with equal ease. At times it was like climbing amid giant skewers, the consequences of a fall suggested in the mutilated trunks of toppled trees below. In other places we explored the labyrinth on foot, following faint trails used by locals hunting honey or lemurs.

We squeezed through passages, our pack straps catching on fingers of stone. Finding handholds and footholds required concentration and testing, to see if the rock was too sharp or if it would hold weight. We stemmed narrow ravines and nervously straddled fins that were like fences topped with broken glass. The rock pierced our boots, leaving holes in the rubber. Usually we came over needle-sharp rises only to descend onto mats of thin soil covering yet more serrated rock. We’d carefully find our balance, then try to figure out what to do next.

We were lucky to cover half a mile a day—imagine trying to cross a city by climbing up each high-rise and then down the other side. Our slow progress made us easy targets for mosquitoes and wasps, and it underscored how difficult biological research here must be, dragging equipment and specimens through the terrain. But even covering far less ground than we’d hoped, we saw hundreds of animals and plants, more than we could recognize. In quieter moments it was possible to imagine a thousand places humans had never been, might never go.

One afternoon, returning from a hot, wet slog, vines along the trail tripped me up, and my right knee landed on a small rock. Back home in New England, where rocks come in rounder forms, I would have walked away with a bruise. But this was tsingy in miniature. A barb of limestone drove in nearly to the bone. It took two days to reach a hospital, where a nurse removed dirt from the wound. “Why were you doing this?” she asked, twisting a swab deep into the hole. She looked up. I was sweating. “I think you are a little dumb,” she said. The tsingy is the perfect foil to human ambition.

THE UNUSUAL FORMATIONS HERE are a type of karst system, a landscape formed from porous limestone that was dissolved, scoured, and shaped by water. The exact processes that carved such an otherworldly stonescape are complex and rare; only a few similar karst formations exist outside Madagascar. Researchers believe that groundwater infiltrated the great limestone beds and began to dissolve them along joints and faults, creating caves and tunnels. The cavities grew, and eventually their roofs collapsed along the same joints, creating line-straight canyons called grikes, up to 400 feet deep and edged by spires of standing rock. Some grikes are so tight that a human traveler has difficulty passing through them; others are as wide as an avenue.

Observing the tsingy from the air, pilots have been reminded of the deep urban canyons of Manhattan, where an angular, chaotic skyline descends into a grid of streets and alleys, buildings and parks, everything underlain by a circulatory system of pipes, sewers, and train tunnels. The metaphor applies to the tsingy’s inhabitants as well, because the formations have become like rows of high-rise apartment buildings, providing shelter to a different array of species at each level.

At the highest reaches there is little soil and no shelter from the sun. Here temperatures often bake above 90°F, and plant and animal life is restricted to creatures that can resist desiccation or move between the pinnacles and the



Vertical pupils identify a seseke, or leaf-tailed gecko, as a nocturnal creature. Its camouflage works so well that the lizard doesn't hide during the day. It simply flattens itself against tree trunks while waiting for darkness and insects to eat.

canyons. Lemurs like the white-furred Decken's sifaka and the brown lemur use the tsingy as a kind of highway, leaping from spire to spire as they travel between fruit trees. In slots and crevices lizards chase insects through gardens of drought-tolerant xerophytes—euphorbias, aloes, spine-covered *Pachypodium*, and other plants that drop long, cablelike roots into the rock searching for water.

In the middle ranges of the high-rise, more niches appear in the canyon walls. Large fruit bats and dark vasa parrots roost here, their cackles and cries echoing through vaulted chambers and crumbling galleries. In shadier spots, bees anchor their nests in holes in the stone.

But it is in the humid grike bottoms, where water and soil collect, that the environment is richest. Here, among arrays of orchids and enormous tropical hardwoods, roams a bestiary: giant snails and fist-size, cricket-like insects, large chameleons, emerald green snakes, and red rats. The lemur-eating fossa—a wiry, thin-coated

mammal with retractable claws that resembles something like a large cat—also patrols the tsingy. Finally, below the soil and the mud are caves and tunnel passages, the subway system where fish, crabs, insects, and other creatures live and commute, some without ever surfacing.

This walled city has sheltered its residents even as Madagascar's other ecosystems disintegrated. Scientists call it the perfect refuge.

THE CONCEPT OF "REFUGE" in biology signifies a safe zone, like a refugee camp, to which living things withdraw as their habitat shrinks. Once they become cloistered in refuges, animals and plants often become increasingly distinct from even their close relatives. Madagascar itself epitomizes this process, so unusual and removed are many of its species from their cousins on the African continent. Lemurs are the island's best known creatures. Their precursors once inhabited Africa but eventually went extinct there, leaving the continent to other primates,



Often no wider than a hiker's shoulders, slot canyons swallow water in the rainy season, funneling much of it to underground chambers. The passages remain moist year-round, supporting dozens of species of invertebrates and amphibians. Most local people who enter the tsingy seek the sweet prize of honey (below).



and today lemurs are found only in Madagascar. Free from the competition that likely drove them to extinction elsewhere, they evolved into richly varied forms, including now vanished species that were big as gorillas and the palm-size mouse lemur, the smallest living primate.

The tsingy also provides refuge on a smaller scale. Protected by walls of stone and wet by seasonal rains, the forest within is very different from the palm savanna curling around it to the east and the coastal areas that flank it to the west. It is a relict of another era, when forest corridors might have linked one side of the island with the other.

In recent millennia a natural drying trend fractured those corridors. Then came people. Since the first humans arrived in Madagascar some 2,300 years ago, nearly 90 percent of the island's original habitat has been destroyed, most of it harvested for timber or felled or burned to create room for crops and, more recently, cattle. As a result, many of the species that lived on the island are thought to have gone extinct.

In the west the tsingy walls in a large portion of forest. The stone serves as a barrier to human settlement and to cattle, which threaten wildlife habitat all across Africa with their plodding hooves and insatiable appetites. The tsingy also acts as a firebreak, shielding the forest from fires—both natural and those set by humans.

“Bemaraha has unusual animal and plant populations in part because the surrounding area has been changed, either by humans or by climate change,” said Brian Fisher, curator of entomology at the California Academy of Sciences. “We’ve found it’s much more diverse than we initially thought.”

ONE SWELTERING MORNING Rakotondravony and I hiked into a tangled forest lining the floor of a grike. We paused at a large ant mound, red ants streaming from the earth. The air around us was damp, smelling of wet basements, and from within the canyon and the forest, a rhythm hung in that thick air, somewhere between heard and felt—the incessant buzzing of a billion insect wings.

Rakotondravony poked gently into the mound, looking for a *renivitsika*, or ant mother, a kind of snake that often lives within a colony's dark interior. We found no snakes, but scanning the area near the mound, Rakotondravony pointed to several plants, including palmlike trees with slender fronds. These, he explained, were another kind of guest that had made an unlikely home in the tsingy's narrow passages. They were a species common in the wet forests of eastern Madagascar but mostly absent from the much drier west. Only here, within the grikes, had the plants escaped the drying sun and roaming wildfires. The plants were just one example. There are certain frogs too, he said, whose nearest known relatives live hundreds of miles away in the eastern forests.

The difficult terrain creates still tinier refuges, where some creatures appear to have evolved in greater solitude, restricted to just a few canyons within the tsingy. John Cleese's lemur, a mouse lemur, and at least two of the pinkie-size dwarf chameleons—some of the world's smallest—illustrate this kind of micro-endemism, where evolution has tailor-fitted animals into tight niches.

Brian Fisher has traveled to the region three times to understand how these refuges formed and how they have shaped the life within them. Through DNA analysis, he is comparing ants from the tsingy region to ants in eastern Madagascar, hoping to pin down exactly when the ants, and the forests, became isolated. The results will provide clues to how animals evolve once they are shut off from other populations, and whether they respond to climate change only by retreating into refuges or by developing new traits as well. The answers, Fisher said, could have implications for the future, as human activity undermines habitats and the planet's climate changes.

Because it is remote and virtually impenetrable, development seems less likely to threaten the tsingy ecosystem than would a shift in regional weather. Lower humidity, less rainfall, increased acidity in the rain—any of these might harm the forests, even the stone itself.

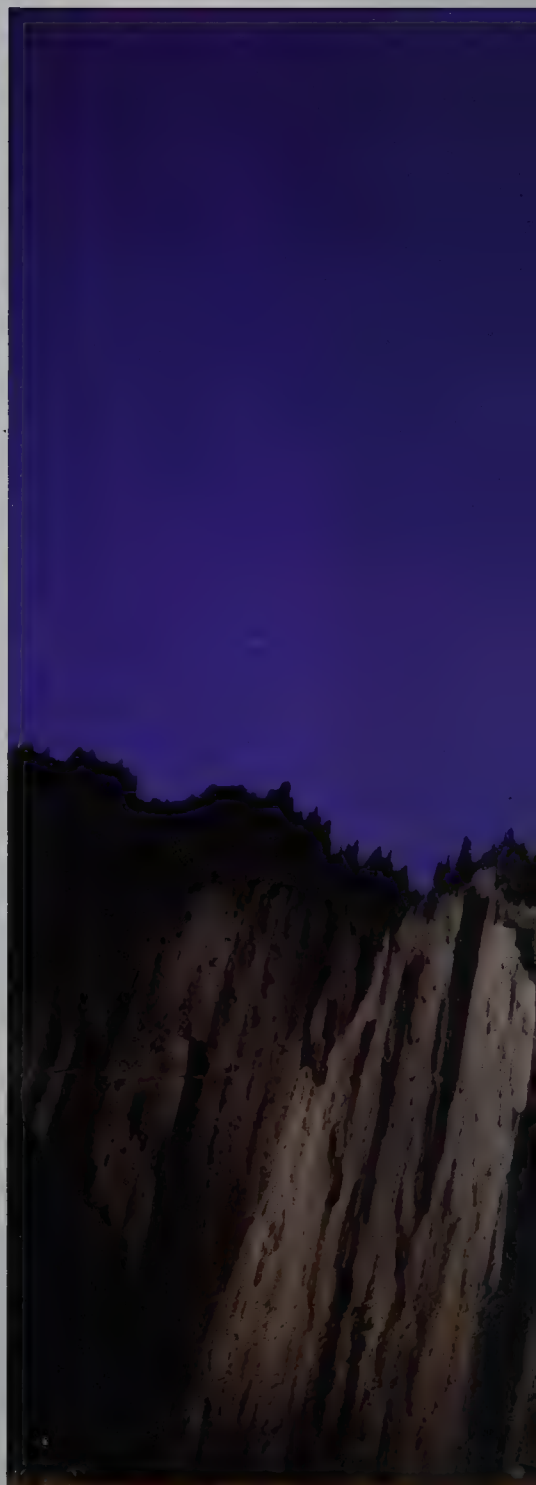
“I wonder how long they could survive, these

relict forests,” Fisher mused. “They could disappear very shortly. It’s a fortress, but it’s vulnerable. The truth is we don’t know very much. We’re just getting a handle on this stuff.”

ON ONE OF MY LAST DAYS in the tsingy, I stood on a lookout platform scanning an expanse of spires and pinnacles, the gray stone purpling in the late afternoon. The platform had been built several years earlier for tourists, but the tourists were no longer coming. The coup had frightened them off. It was bad news for the park; 50 percent of its budget comes from fees associated with tourism. An official told me that 2008 had been a good year, but 2009 wasn’t looking promising. In April 2008, 147 visitors had come to Tsingy de Bemaraha; during the same month in 2009, after the coup, there had been 12. The official wasn’t sure how he’d make up the difference or what effect it would have on the reserve, on employee salaries, on the development and education programs that give poor local people reasons to care about preservation. He smiled tiredly. “We will become creative.”

Not far away a troop of sifakas leaped through the pinnacle tops, clearing deep canyons, landing on razors of rock. With their bright white fur, the lemurs look like polar creatures marooned in the tropics. They move through one of the world’s most formidable landscapes as though physical laws mean nothing, as though such laws are arguments made by less agile creatures to explain away their own clumsiness.

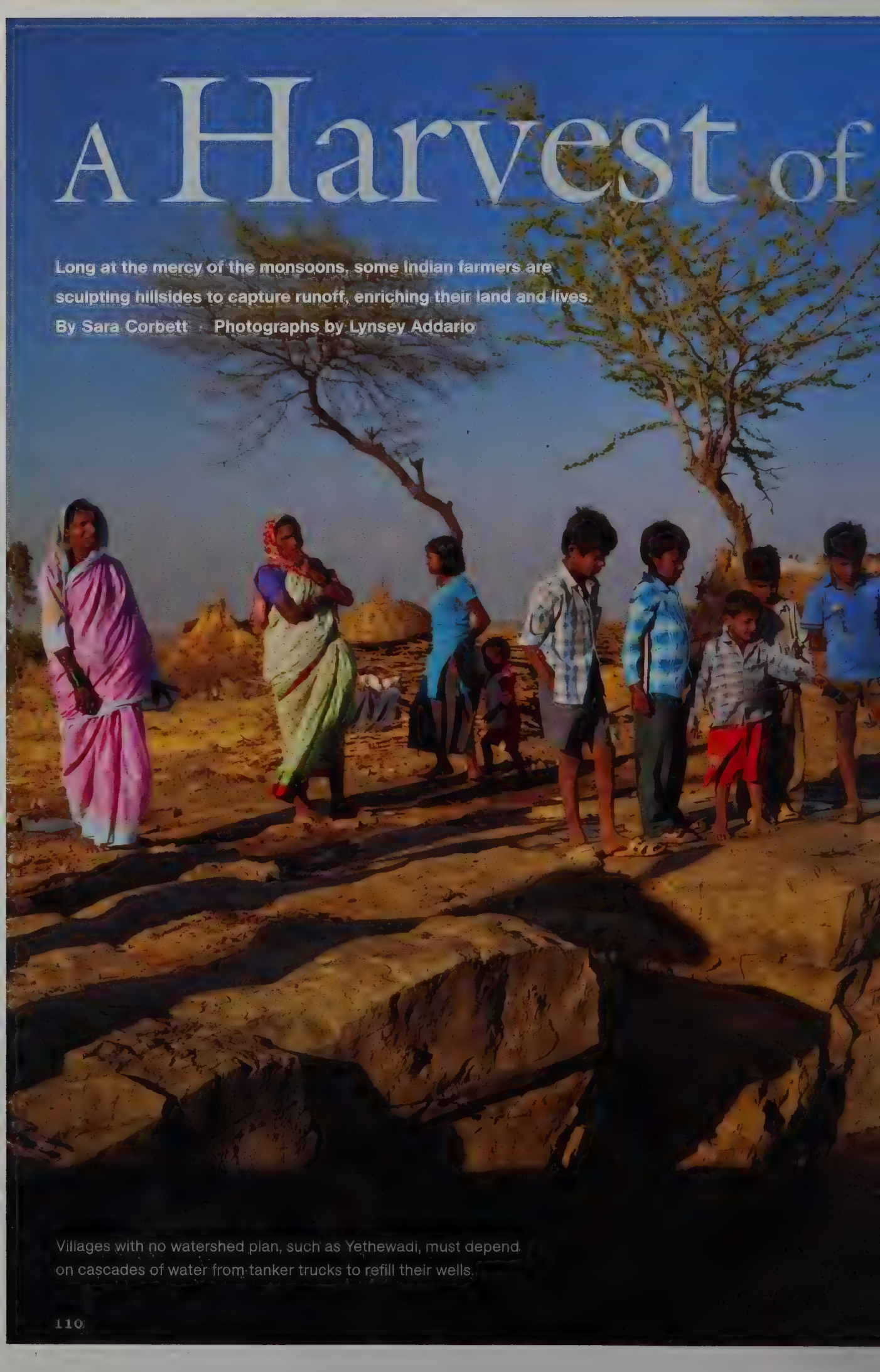
The sifakas disappeared with the light. Parrots arced through the sky, passing large, silent bats. In the canyons below, the forest flattened into a gray smudge. We climbed down and headed for camp, playing our headlamps through the trees. Thousands of eyes glinted in the darkness, orange and green jewels, the eyes of nocturnal lemurs known only here, of geckos with skins as smooth and iridescent as a trout’s, of large spiders and moths, their bodies thin as shadows. The night itself was becoming a refuge, a kind of temporary continent, enclosing the stone city and all its creatures, the named and the still nameless. □





Nightfall does nothing to soften the spiny ramparts, yet cooler temperatures and rising humidity entice many nocturnal creatures to emerge. Says biologist Steven Goodman, one of the few scientists to make repeat visits, "We've just touched the surface as far as finding out what lives there."

A Harvest of



Long at the mercy of the monsoons, some Indian farmers are sculpting hillsides to capture runoff, enriching their land and lives.

By Sara Corbett · Photographs by Lynsey Addario

Villages with no watershed plan, such as Yethewadi, must depend on cascades of water from tanker trucks to refill their wells.

Water





FARMERS IN INDIA do a lot of talking about the weather—especially, it seems, when there is no weather in sight. During the month of May, when the land heats up like a furnace and most fields lie fallow, when wells have run dry and the sun taunts from its broiling perch in a cloudless sky, there is no topic more consuming—or less certain—than when and how the summer monsoon will arrive. The monsoon season, which normally starts in early June and delivers more than three-quarters of the country's annual rainfall in less than four

months, will begin gently, like a deer, the farmers say, and later it will turn into a thundering elephant. Or it will start as an elephant and then turn into a deer. Or it will be erratic and annoying right through, like a chicken. In other words, nobody really knows. But still, everybody talks.

This was the case one day in 2008 when an extended family of farmers from a village called Satichiwadi climbed up to the hilltop temple of their village goddess, planning to ask her for rain. It was mid-May and 106 degrees, and Satichiwadi, a village of 83 families that sits in a parched rural valley in the state of Maharashtra, about a



A fickle monsoon sky disappoints farmers crossing the Bhima River on a Hindu pilgrimage to the city of Pandharpur. Instead of a much needed downpour, the clouds deliver a mere sprinkle.

those distant clouds. It was gambling time for rain-dependent farmers across India. In the weeks leading up to the monsoon, many would invest a significant amount of money, often borrowed, to buy fertilizer and millet seeds, which needed to be planted ahead of the rains. There were many ways to lose this wager. A delayed monsoon likely would cause the seeds to bake and die in the ground. Or if the rain fell too hard before the seedlings took root, it might wash them all away.

"Our lives are wrapped up in the rain," explained a woman named Anusayabai Pawar, using a countrywoman's version of Marathi, the regional language. "When it comes, we have everything. When it doesn't, we have nothing."

In the meantime, everyone kept scanning the empty sky. "Like fools," said an older farmer named Yamaji Pawar, sweating beneath his white Nehru cap, "we just sit here waiting."

IF THE PEOPLE OF SATICHIWADI once believed the gods controlled the rain, they were starting to move beyond that. Even as they carried betel nuts and cones of incense up to the goddess's temple, even as one by one the village women knelt down in front of the stone idol that represented her, they seemed merely to be hedging their bets. Bhaskar Pawar, a sober-minded, mustachioed farmer in his 30s, sat on one of the low walls of the temple, watching impassively as his female relatives prayed. "Especially the younger people here understand now that it's environmental," he said.

Satichiwadi lies in India's rain shadow, an especially water-deprived swath of land that includes much of central Maharashtra. Each year after the summer monsoon pounds the west coast of India, it moves inward across the plains and bumps against the 5,000-foot peaks

hundred miles northeast of Mumbai, hadn't had any significant rainfall for seven months. Most of India at this point was caught in an inescapable annual wait. In New Delhi, the heat had triggered power cuts. Dust storms raced, unmitigated by moisture, across the northern states. Tanker trucks clogged the rural highways, delivering government-sponsored loads of drinking water to villages whose wells had run dry. Meanwhile, radio newscasters were just beginning to track a promising swirl of rain clouds moving over the Andaman Islands, off the southeast coast.

All day, villagers had been speculating about





Reveling in the luxury of a soaking, guests at the Wet 'N Joy theme park near Shirdi dance to a Bollywood beat. Tapping the drought-prone region's aquifer for non-essential uses diverts water from farmers who need it desperately.

of the Western Ghats, where the clouds stall out, leaving the leeward side punishingly dry.

In an effort to lessen their dependence on the monsoon, the village's residents had signed on to an ambitious, three-year watershed program designed to make more efficient use of what little rain does fall. The program was facilitated by a nonprofit group called the Watershed Organization Trust (WOTR), but the work—a major relandscaping of much of the valley—was being done by the villagers themselves. Teams of farmers spent an average of five days a week digging, moving soil, and planting seedlings along the ridgelines. WOTR, which has led similar projects in more than 200 villages in central India, paid the villagers for roughly 80 percent of the hours worked but also required every family to contribute free labor to the project every month—a deliberate move to get everyone invested.

From the vantage point of the temple, the effort was evident: Beyond the small grids of tile-roofed mud homes and the sun-crisped patchwork of dry fields, many of the russet brown hillsides had been terraced, and a number of freshly dug trenches sat waiting to catch the rain. If only, of course, the rain would come.

In Satichiwadi the anticipation was high. "Very soon," Bhaskar said, "we will know the value of this work."

COMPLEX AND CAPRICIOUS, the South Asian monsoon—widely considered the most powerful seasonal climate system on Earth, affecting nearly half the world's population—has never been easy to predict. And with global warming skewing weather patterns, it's not just the scientists who are confounded. Farmers whose families for generations have used the *Panchangam*, a thick almanac detailing the movement of the Hindu constellations, to determine when the monsoon rains are due and thus when to plant their crops, lament that their system no longer works reliably.

Sara Corbett is a contributing writer for the New York Times Magazine. Lynsey Addario photographed Bhutan for National Geographic in March 2008.

"It is a bit of a puzzle," said B. N. Goswami, director of the Indian Institute of Tropical Meteorology, based in Pune. After studying five decades of rain gauge data for central India, Goswami and his colleagues concluded that although the amount of rainfall has not changed, it is coming in shorter, more intense bursts, with fewer spells of light rain between, mirroring a larger pattern of extreme weather worldwide.

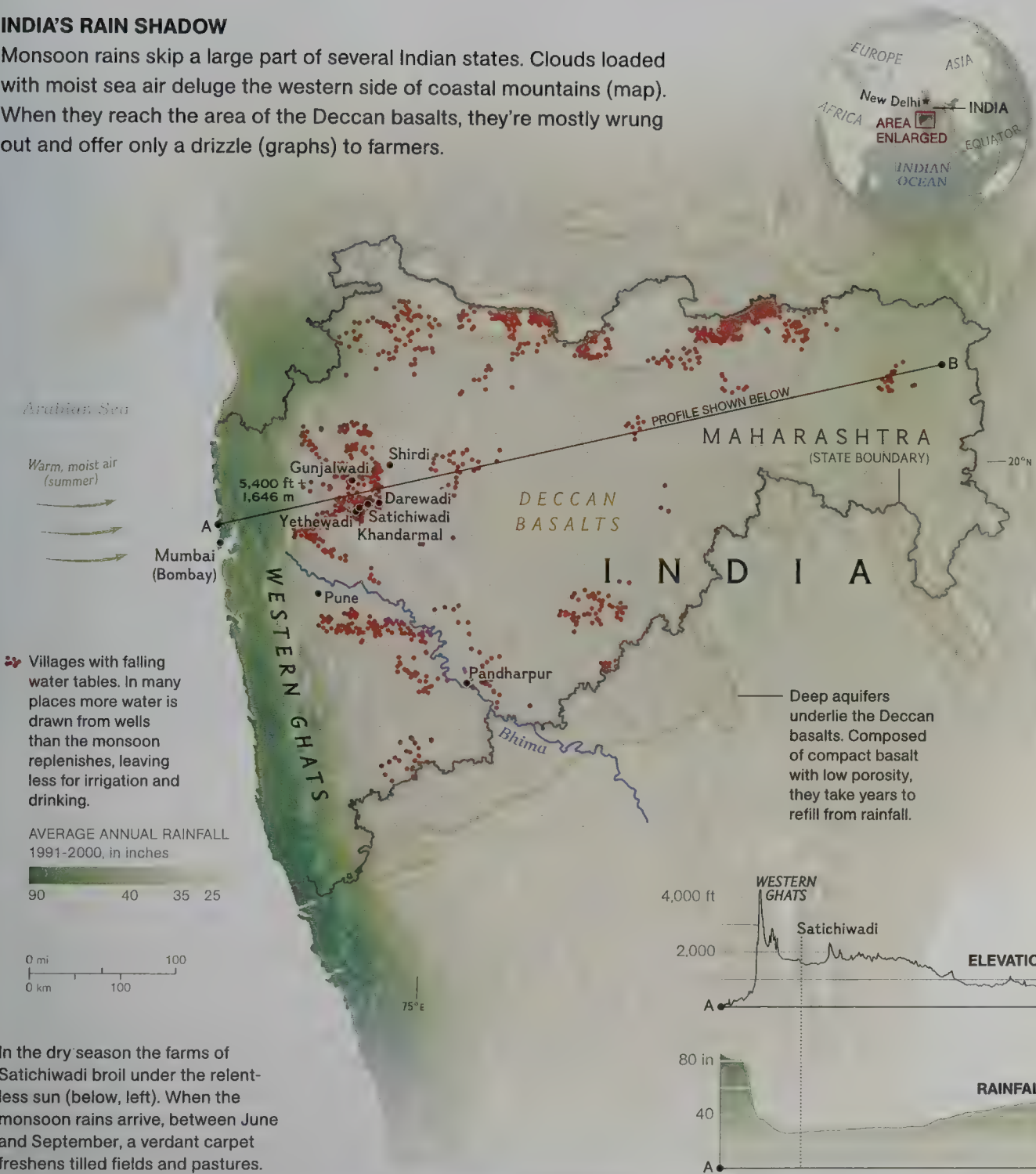
Groundwater has helped some farmers cope with erratic rains. But India's water tables are dropping precipitously, as farmers who now have access to electric pumps withdraw water faster than the monsoon can replenish it. According to the International Water Management Institute, based in Sri Lanka, half the wells once used in western India no longer function. "Thirty years ago we could strike water by digging 30 feet," said the village chief in Khandarmal, a dusty settlement of about 3,000 people perched on a ridge about 20 miles from Satichiwadi. "Now we have to go to 400 feet." Even that is chancy. Over the years the villagers have drilled a total of 500 wells. Ninety percent of them, he estimated, have gone dry.

Water shortages throw farmers into an unrelenting cycle of debt and distress, driving many—by one estimate up to a hundred million each year—to seek work in factories and distant, better irrigated fields. During the dry months, between November and May, you see them on the roads: families creaking along in bullock carts, truck taxis jammed with entire neighborhoods of people on the move. The stakes can seem impossibly high. According to government figures, the number of suicides among male farmers in Maharashtra tripled between 1995 and 2004.

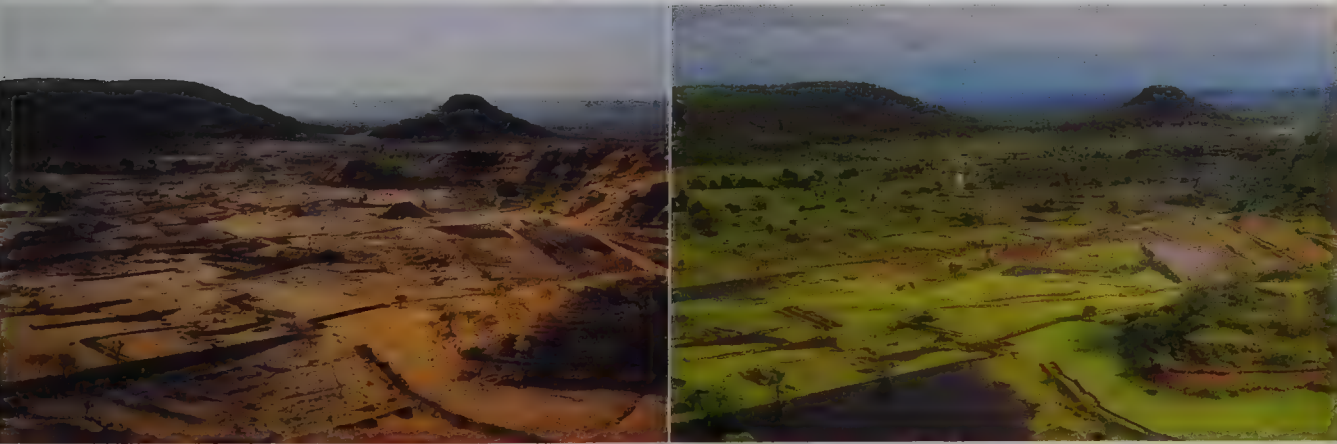
One afternoon outside a sugarcane processing factory not far from Satichiwadi, I met a boy named Valmik. He was 16, with a sweet smile and out-turned ears, wearing a brown T-shirt and pants that were ripped across the seat. Standing in front of his bullock cart loaded with two tons of freshly cut sugarcane, he explained that he had driven his two-oxen cart 110 or so miles with his older brother and widowed mother to spend five months working in

INDIA'S RAIN SHADOW

Monsoon rains skip a large part of several Indian states. Clouds loaded with moist sea air deluge the western side of coastal mountains (map). When they reach the area of the Deccan basalts, they're mostly wrung out and offer only a drizzle (graphs) to farmers.



In the dry season the farms of Satichiwadi broil under the relentless sun (below, left). When the monsoon rains arrive, between June and September, a verdant carpet freshens tilled fields and pastures.



the fields with a sickle. His arms and hands were heavily scarred from the work.

Speaking softly, Valmik detailed one of the crueler paradoxes of rain dependence. A year earlier his family had borrowed 40,000 rupees (about \$800) from a moneylender to cover expenses such as seeds and fertilizer for their fields at home and hadn't been able to pay it back. Why? Because there hadn't been enough rain,

“Where the rain runs, we make it walk; where it walks, we make it crawl,” said Crispino Lobo of the Watershed Organization Trust.

and the seeds had broiled in the ground. What would they do when the debt was paid off? The same thing they'd done for the past three years after a season of cutting sugarcane: They would borrow again, plant more seeds, and revive their hopes for a decent monsoon.

GIVEN THE ENORMITY of India's water issues, encouraging single villages to revive and protect their own watersheds can seem a feeble response to a national crisis. But compared with controversial top-down, government-led efforts to build big dams and regulate the wanton drilling of deep wells, a careful grassroots effort to manage water locally can look both sensible and sustainable. When I visited Khandarmal with Ashok Sangle, one of the civil engineers who works for WOTR, the people there described a failed \$500,000 development project to pump water several miles uphill from the nearest river. Sangle shook his head. “What is the logic of pulling water up a slope,” he asked, “when you can more easily catch the rain as it flows down?”

The idea behind watershed development is simple: If people cut fewer trees, increase plant cover on the land, and build a well-planned series of dams and earthen terraces to divert and slow the downhill flow of rainwater, the soil has more time to absorb moisture. The terracing

and new vegetation also control erosion, which keeps nutrient-rich topsoil from washing or blowing away, and this in turn boosts the productivity of agricultural land.

“Where the rain runs, we make it walk; where it walks, we make it crawl,” explained Crispino Lobo, one of WOTR's founders, using an analogy the organization often employs when introducing the concepts behind watershed work to farmers. “Where it crawls, we make it sink into the ground.” Runoff is reduced. The water table for the whole area rises, wells are less apt to go dry, and especially with some simultaneous efforts to use water more efficiently, everybody needs to worry less about when it will rain again.

The benefits—at least hypothetically—spool outward from here. More productive farmland means more food and better health for the villagers, and it opens the possibility of growing cash crops. “The first thing people do when their watershed regenerates and their income goes up,” Lobo said, “is to take their kids out of the fields and put them in school.”

Lobo began working on water issues in the early 1980s through a development program funded by the German government. WOTR is now directed by Marcella D'Souza, a medical doctor and Lobo's wife, whose efforts to involve women in watershed redevelopment have earned international recognition. They believe there is an important emotional dimension to watershed work as well. “If people are able to improve the land and restore the soil, you start seeing a change in how they see themselves,” Lobo said. “The land reflects some hope back at them.”

To be clear, this is not always easy. Since the late 1990s, both the Indian government and a variety of nongovernmental organizations have funneled some \$500 million annually into redeveloping watersheds in drought-prone rural areas. But experts say many such endeavors have fallen short of their goals or proved unsustainable, in large part because they have focused too much on the technical aspects of improving a watershed and too little on navigating the complex social dynamics of farming villages. In other words, no effort gets very far without a lot of hands-on



During a three-year watershed project, residents of Satichiwadi dig a trench to catch rain as it races downhill. Landless villagers are paid for this work. Landowners, whose fields will benefit from the resulting rise in the water table, donate some of their labor.

cooperation. And if you're wondering what could possibly be so complex about a smallish group of marginal farmers living in the middle of nowhere, you should go to Satichiwadi and spend some time with the Kales and the Pawars.

SATICHIWADI LIES several miles off a two-lane road that crosses a high, semiarid plain dotted with meager-looking farms and drought-resistant neem trees. The road to the village, completed last year, remains little more than an axle-smashing series of dirt switchbacks descending some 600 vertical feet from the high bluffs to the flat valley floor. Many of the villagers still come and go the old-fashioned way, making a 45-minute, sweaty hike up a vertiginous footpath.

Members of the Pawar family like to say they got here first, about a hundred years ago, when this was a mostly uninhabited, forested place, and great-grandfather Soma Pawar, a nomadic

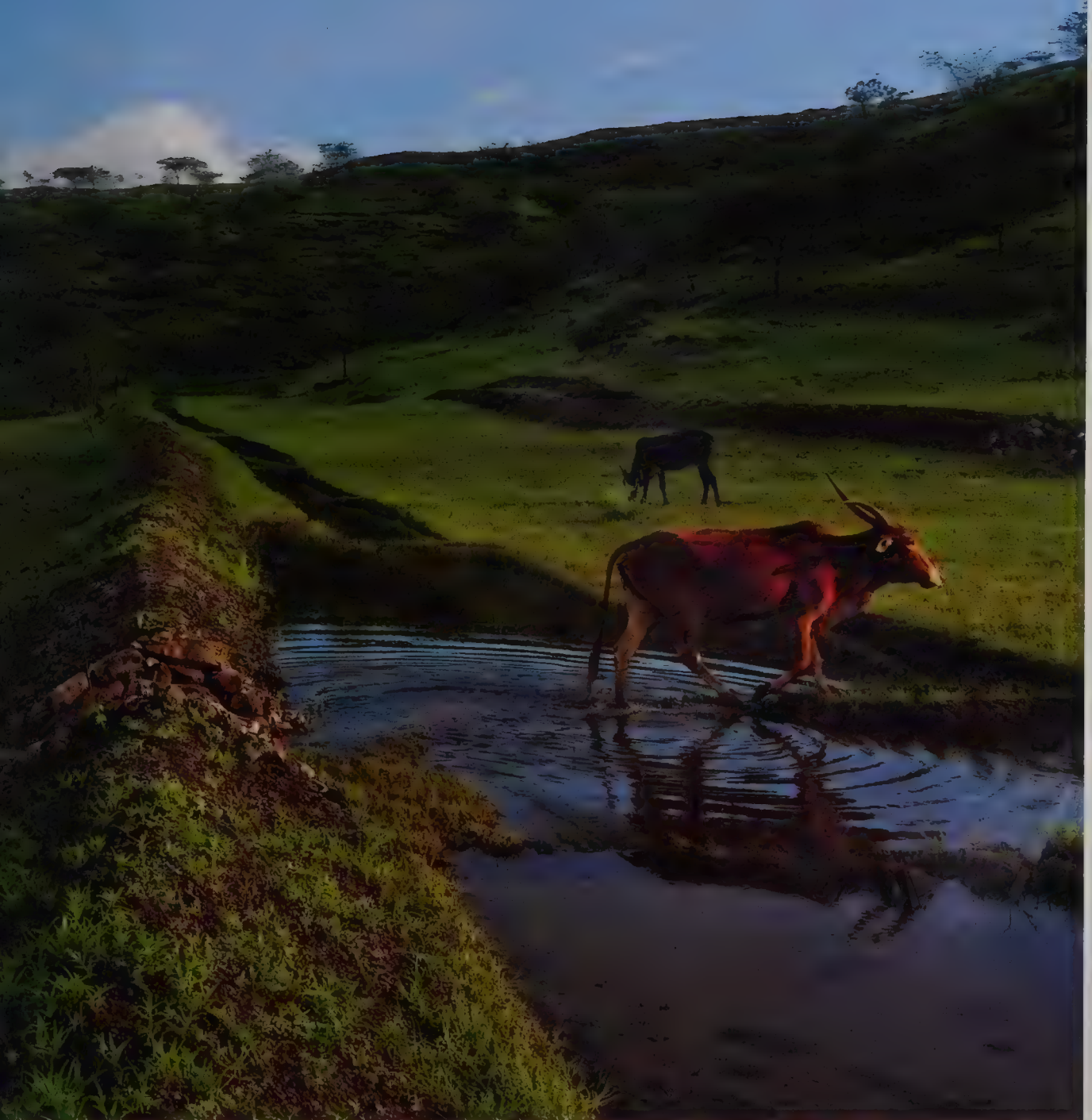
shepherd belonging to the Thakar tribe, made his way down from the high buttes and liked what he saw. Sometime after that—precisely how long is in dispute—great-grandfather Goma Genu Kale, also a Thakar, is said to have ambled in and taken up residence as well.

For a time the Kale and Pawar families got along just fine, living close together in a small group of thatched-roof, mud-brick homes built near the temple. Working together, they cleared trees and tilled the land to grow rice and other grains. Then, about 40 or 50 years ago, the Kales abruptly moved to the other side of the valley. The reason is also in dispute: The Kales say they simply got tired of tromping the half mile or so back and forth to their millet fields. The Pawars say, somewhat huffily, that the Kales got sick of the Pawars.

Whatever the case, the two families—despite being separated by no more than 500 yards of fields—stopped (Continued on page 126)



Pooled amid the system
of trenches and dams
created in Satchiwadi
rainwater soaks slowly
into the ground. That
moisture will help sus-
tain crops and increase
grazing for herds of
cattle and goats.



The Karande family grows water-intensive onions as a cash crop, benefiting from more than a decade of land contouring around Darewadi. Before, they subsisted on millet scratched from parched fields.





Prohibited from felling trees under Satichiwadi's new watershed rules, Nandabai (at left) and Sakhubai Thama Pawar prepare a meal for 20 family members over fires fueled by small branches.





talking. They held their own independent holy weeks to celebrate the goddess Sati and pointedly stopped attending one another's weddings. The Pawars stopped calling the Kales by name, referring to them instead as the "Fed Up People." The hamlet where the Kales now live is known simply as *Vaitagwadi*, Fed Up Town.

As Satichiwadi's harmony deteriorated, another kind of diminishment began. Sheep and

Darewadi's farmers are getting their first taste of prosperity, growing onions, tomatoes, and lentils and selling the surplus.

cows trampled the grassland; the last of the trees disappeared. Crops too began to falter. Farmers gave up growing rice, which required so much water. By March each year, most of the wells across the valley had dried up.

With both food and income scarce, villagers started migrating to work on sugarcane plantations, on road crews, and in brick factories. "If you had come even three years ago during the dry season," Sitaram Kale, a farmer who also owns a small shop in Satichiwadi, told me, "you would have found only very old people and very small children living here."

The villagers did not easily come around to the idea that they could work together and revive the valley. Getting them to set aside their differences took months of meetings, several exploratory "exposure visits" to other villages where WOTR's watershed programs had been successful, and the diligent attention of a high-energy young social worker named Rohini Raosaheb Hande, who hiked the path into Satichiwadi every other day for six months. Hande was the second social worker WOTR had sent to Satichiwadi; the first had quit after a few weeks. "She told me it was a place without hope," Hande recalled. "Nobody would even talk to her."

Such resistance is common. In the village of Darewadi, where the watershed work was completed in 2001, one villager had chased

WOTR employees away with an ax. Because the organization encourages simultaneous social reconfiguration and environmental change, its efforts often initially rub farmers the wrong way. WOTR mandates, for example, that village-level water decisions include women, landless people, and members of lower castes, all of whom might ordinarily be excluded. To give the local greenery a chance to recover, villagers must also agree to a multiyear ban on free-grazing their animals and cutting trees for firewood. Finally, they must trust the potential benefits of watershed work enough to sign on to the sheer tedium it entails—three to five years spent using pickaxes and shovels to move dirt from one spot to another to redirect the flow of rainwater.

In Darewadi an elderly farmer named Chimaji Avahad, who lives with his extended family in a brightly painted two-room home hemmed in by sorghum fields, recalled the early difficulties of adjusting to the new rules. He was taken aback, he told me, by the talkative women who filled his life. "Each one of them—my wife, daughters, daughters-in-law, and even granddaughters—has an opinion," he said, amused. His wife, Nakabai, a tiny woman with a face wizened by years working in the fields, immediately chimed in, "It was a very good change."

A walk around Darewadi confirms this. By all accounts a grim and waterless place before the project began more than a decade ago, it now boasts bushes and trees and fields of wild grass. The village's wells now remain full, even at the height of the dry season. With more water, Darewadi's farmers are getting their first taste of prosperity, moving from producing only enough millet to feed themselves to growing onions, tomatoes, pomegranates, and lentils and selling the surplus in nearby market towns. Avahad now puts about 5,000 rupees (about a hundred dollars) a year in the bank. Darewadi's women have used their new influence to ban the sale of alcohol and also have formed women's savings groups—a common feature of WOTR projects—that collect a small monthly fee and in turn loan money to members who need it to



In the village of Gunjalwadi, one-year-old Sarika Walunj's monthly weigh-in records her growth. The watershed program here has led to more crops and better nutrition and to the increased prosperity that supports this day care center, staffed by local women.

pay for weddings or veterinary care or the solar lights that now dot the village at night.

WHEN I RETURNED TO SATICHIWADI in January, the villagers were finding some hope in their own land. The young trees on the ridgetops were green and thriving. The hills and fields had been contoured with small dams and trenches, looking like tidy ripples arcing across a brownish pond. Bhaskar Pawar—the farmer who had sat in the temple with me eight months earlier, waiting to see whether the watershed work would pay off—excitedly reported that the water level in the village wells was about ten feet higher than normal. And this was a good thing, because the monsoon had once again confounded the villagers. Not a drop had fallen over the valley during the month of June or in the first three weeks of July. Their millet seeds had withered and died. “It was a miserable time,” Bhaskar recalled.

And yet when the rain did come—in torrents in late July—they were ready to catch the water and put it to use. They’d spent the fall months harvesting tomatoes. Now they were working on onions and sorghum. And they were also harvesting something less tangible: a newfound, tenuous harmony.

One morning I watched as Sitaram Kale, the shopkeeper and one of nine members of the Village Watershed Development Committee, rode his bike over to the Pawars’ settlement to spread the word about a watershed-related meeting to be held later in the dusty schoolyard on his side of town. He passed the news to a voluble, grandmotherly woman named Chandrakhanta Pawar, who disseminated it by ducking her head into several of her neighbors’ homes, assuring that each would come and participate. “There’s a meeting later this morning over in Fed Up Town,” she announced. “One of the Fed Up People just came over to say so.” □

WHEN CROCS RULED



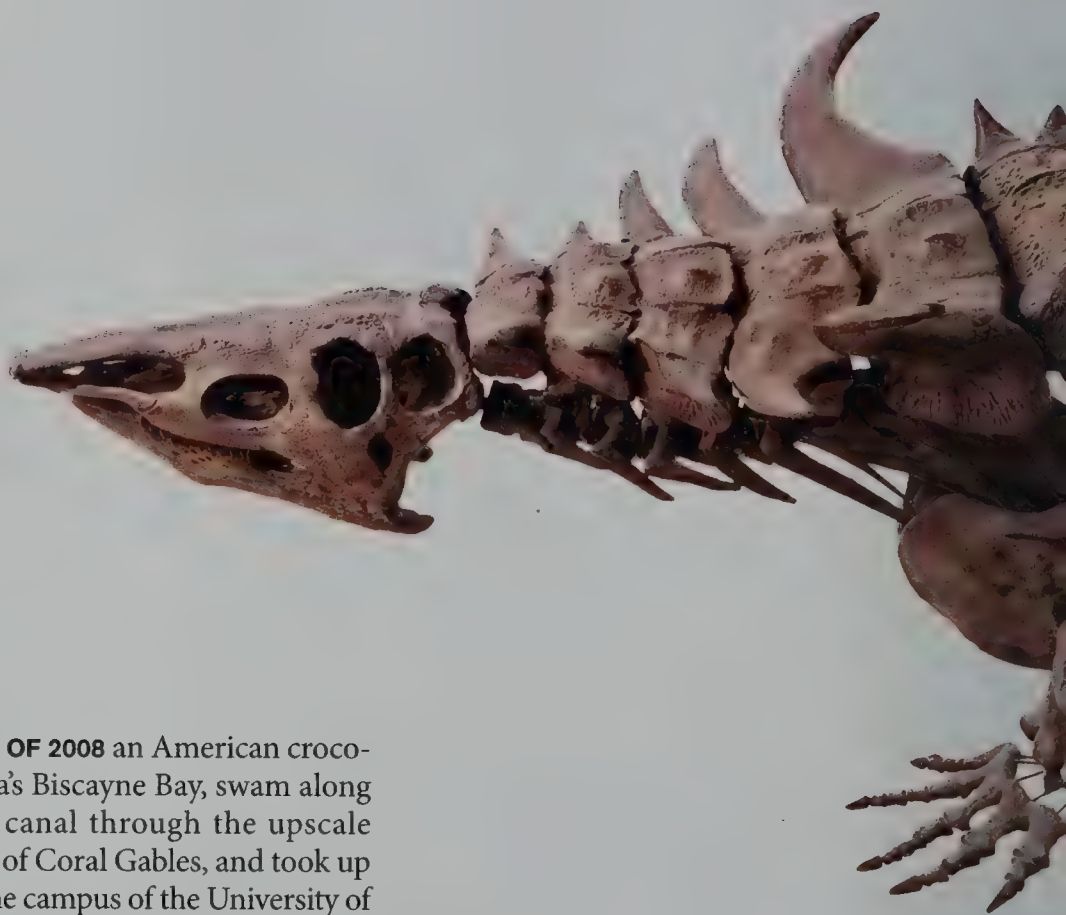
This vigilant yellow eye belongs to a Nile crocodile, a fearsome hunter perfected by epochs of evolutionary trial and error. Over the course of 240 million years, these predators and their kin have come to rule the netherworld between dry land and deep water. But as their habitats dwindle, many croc species face an uncertain future.





Eighty million years ago *Deinosuchus* (at right) would have hunted much like its modern descendant, the American alligator, using stealth and a viselike bite to snatch a 30-foot *Albertosaurus* from the shallows and drag it into deep water.





IN THE SUMMER OF 2008 an American crocodile left Florida's Biscayne Bay, swam along a yacht-lined canal through the upscale neighborhood of Coral Gables, and took up residence on the campus of the University of Miami, where it occasionally interrupted its sunbathing on the banks of Lake Osceola to munch on a turtle. The snaggletoothed croc was a daily reminder to students that they'd chosen a school in sunny, subtropical Florida and not in, say, Iowa.

This wasn't the first crocodile to appear on campus, but it became the most famous. People took to calling it Donna, after university president and former Cabinet member Donna Shalala—this despite the fact that it turned out to be a male. Donna occasionally basked on the grass just yards from the university pub, prompting the relocation of a few picnic tables but causing no further disruption.

Early on October 1 someone killed Donna, an act that outraged students and faculty and broke both state and federal laws: The American crocodile is classified as endangered by Florida law and threatened by federal law. A month after the crime, police arrested a man and a teenage boy, who allegedly wanted the skull as a trophy.

Mel White is a frequent contributor. His articles have covered, among others, pelicans, jaguars, Philippine eagles, and the elusive ivory-billed woodpecker.

It's tempting to use Donna as a metaphor for the plight of the world's 23 recognized species of crocodilians, a group of related reptiles including crocodiles, alligators, caimans, and gharials. Having endured millions of years of planetary climate change, tectonic-plate musical chairs, and other ecological vicissitudes, they face a new challenge to their survival: us.

In the 1970s the population of crocodiles in Florida may have dropped to fewer than 400 individuals. The state's booming human population had crowded them out of most of the protected saltwater bays where they once lived, and many were killed by poachers for their hides, stuffed for museum displays, or captured for live exhibits.



An early croc forerunner, *Desmatosuchus* inhabited low-lying floodplains in Texas, New Mexico, and Arizona in the late Triassic. Its bony plates, or osteoderms, are also found in living crocodilians.

In the years since, conservation measures have led to a rebound in Florida crocs, which may now number some 2,000. “Crocodile management isn’t rocket science,” says Steve Klett, manager of Florida’s Crocodile Lake National Wildlife Refuge. “If you protect their habitat and protect them from being killed, they will respond. The big issue now is the restricted range: Once they’ve occupied all the available habitat, where will they go?”

In Donna’s case, to an urban area where he shouldn’t have been living—except that there was probably no better alternative.

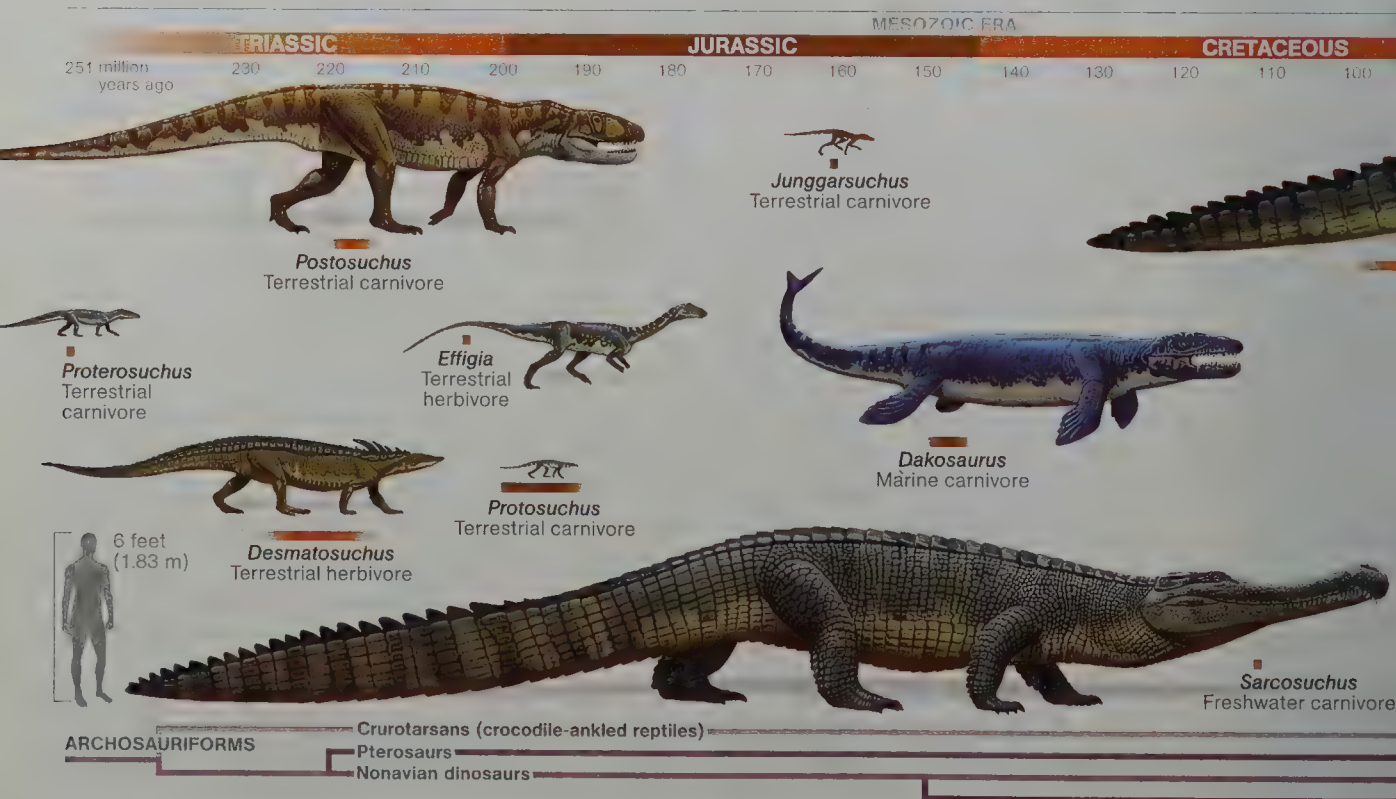
TODAY’S CROCODYLIANS are often said to be survivors from the age of dinosaurs. That’s true

as far as it goes: Modern crocs have been around for some 80 million years. But they’re only a small sampling of the crocodilian relatives that once roamed the planet—and, in fact, once ruled it.

Crurotarsans (a term paleontologists use to include all croc relatives) appeared about 240 million years ago, generally at the same time as dinosaurs. During the Triassic period, crocodile ancestors radiated into a wide array of terrestrial forms, from slender, long-legged animals something like wolves to huge, fearsome predators at the top of the food chain. Some, like the animal called *Effigia*, walked at least part of the time on two legs and were probably herbivores. So dominant were crurotarsans on land that



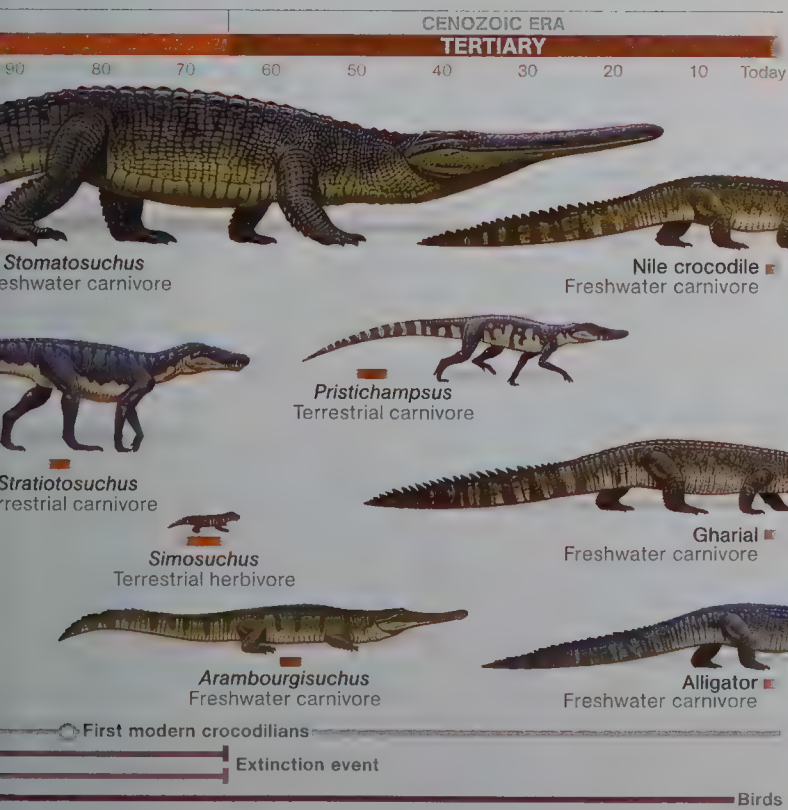
CROC EVOLUTION The early predecessors of crocodilians, along with pterosaurs, nonavian dinosaurs, and birds, evolved from a common ancestor, then diversified spectacularly (below). In myriad sizes and shapes, they established niches in marine and terrestrial habitats worldwide and feasted on everything from flowers to flesh. Supreme adaptability helped crocs survive many global extinctions, including the one 65 million years ago that killed off pterosaurs and dinosaurs.



MARIEL FURLONG, NG STAFF. ART: RAUL MARTÍN. SOURCES: JAMES CLARK, GEORGE WASHINGTON UNIVERSITY; CHRISTOPHER BROCHU, UNIVERSITY OF IOWA; DIEGO POL, MUSEO PALEONTOLOGICO EGIDIO FERUGLIO, ARGENTINA; ALAN TURNER, STONY BROOK UNIVERSITY; STERLING NESBITT, AMERICAN MUSEUM OF NATURAL HISTORY



Famous for its bone-crushing jaws, a Nile crocodile (above) also dominates with the help of powerful legs, which allow it to strike quickly and pull down adult wildebeests. Its tail helps propel its surprising leap, demonstrated in Bazoulé, Burkina Faso (above left), where people have worshipped crocs for centuries.



MODERN CROCODYLIANS

The three families living today are easily distinguished.



Crocodiles: Most but not all lower teeth are visible when mouth is closed.



Gharials: Long, very narrow snout with many narrow teeth exposed when mouth is closed; males have a bulbous nose.



Alligators and caimans: Most have no lower teeth showing when mouth is closed.

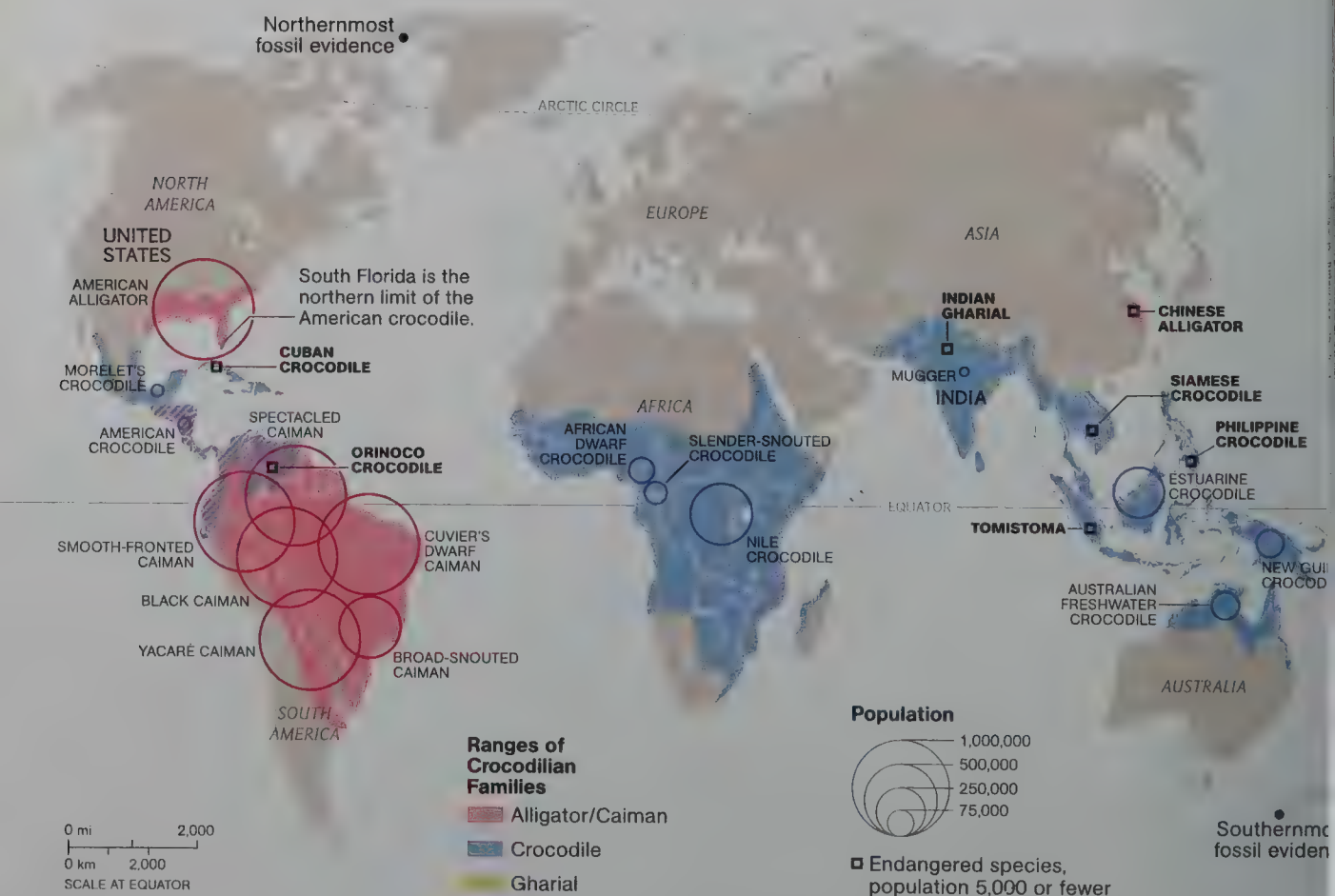


Armed Louisianans snare an eight-foot alligator on a chicken-baited hook. "It's like pulling in a log," says a hunter, "until the alligator sees you. Then the battle begins." The state manages a healthy annual harvest of some 34,000 wild and 240,000 farm-raised alligators. Last year the hides and meat brought in nearly \$60 million.





CROC WORLD Living crocodilians, which include two species of alligators, six kinds of caimans, 14 types of crocodiles, and the lone species of gharial, all reside within 2,600 miles of the Equator, though their ancestors ranged nearly from Pole to Pole. Some species, such as the American alligator and Nile crocodile, are thriving, but many others are declining as humans expand into croc habitat. Some, such as the African dwarf crocodile (above), are hunted for their meat. A few species, notably the gharial, may go extinct within a decade in the wild.



WITH LAND-BASED DINOSAURS AND SEA MONSTERS GONE, WHY DIDN'T CROCS TAKE OVER THE EARTH ONCE AND FOR ALL?

dinosaurs were limited in the ecological niches they could occupy, staying mostly small in size and uncommon in number.

At the end of the Triassic, about 200 million years ago, an unknown cataclysm wiped out most crurotarsans. With the land cleared of their competitors, dinosaurs took over. At the same time, huge swimming predators such as plesiosaurs had evolved in the ocean, leaving little room for interlopers. The crocs that survived took on a new diversity of forms, but eventually they lived, as their descendants do today, in the only places they could: rivers, swamps, and marshes.

Restricted ecological niches may have limited the creatures' evolutionary opportunities—but also may have saved them. Many croc species survived the massive K-T (Cretaceous-Tertiary) extinction 65 million years ago, when an asteroid dealt a death blow to the dinosaurs (except for birds, now viewed as latter-day dinosaurs) and a broad range of other life on land and in the oceans. No one knows why crocs lived when so much died, but their freshwater habitat is one explanation: Freshwater species generally did better during the K-T event than did marine animals, which lost extensive shallow habitat as sea level dropped. Their wide-ranging diet and cold-blooded ability to go long periods without food may have helped as well.

With land-based dinosaurs and sea monsters gone, why didn't crocs take over the Earth once and for all? By then mammals had begun their evolutionary march toward world domination. Over time the most divergent lines of crocs died out, leaving the squat-bodied, short-legged forms we're familiar with.

"THE MAIN CHANGE in recent crocodilian conservation has been the decline in illegal hunting for skins," says John Thorbjarnarson of the Wildlife Conservation Society, a leading expert on the group. It's been replaced by legally managed ranching and harvesting, allowing some species to rebound. "Whereas 20 years ago there may have been 15 or 20 species that were listed as endangered," Thorbjarnarson says, "now there

are really only seven, all reflecting the loss of most of their habitat."

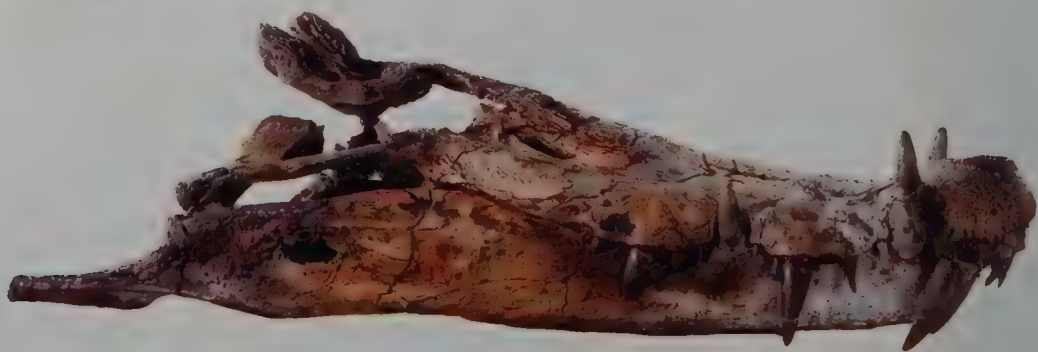
Species such as the Chinese alligator and the Philippine crocodile have virtually no natural habitat left, squeezed out of their former ranges by agricultural and urban growth. And even species that have responded positively to conservation measures face a problem that's a larger scale version of Donna's: contact, and often conflict, with humans.

The Indian gharial, a skinny-snouted species that once ranged from Pakistan to Myanmar, suffered serious population declines in the mid-20th century. Recovery in the 1980s and 1990s, thanks to decreased poaching and establishment of protected areas, gave conservationists reason to believe it was out of trouble. But recent surveys have shown that gharial numbers have once again crashed, this time to critically endangered status.

Gharials eat only fish and require a specialized habitat of swiftly flowing rivers with sandy banks. Factors in their decrease include persecution by fishermen (who see them as competitors), drowning in fishing nets, and destruction of their habitat by sand mining and other human activities. In addition, a significant gharial population on India's Chambal River was decimated between December 2007 and February 2008 by what some biologists believe was pollution. The wild population of gharials has shrunk to a few hundred individuals living only in India and Nepal.

Some crocodilians found in remote parts of the world are not in immediate danger, and others such as the American alligator have made dramatic recoveries. But it remains to be seen how many can endure in a world where their wetland homes are coveted by people from subsistence farmers to golf course designers—and where some species make themselves less than welcome by eating pets and even people.

Thought to be an origin of ancient dragon myths, crocodilians and their ancestors have faced nearly unimaginable changes to the planet and found ways to adapt to them all. As the pace of environmental change quickens, though, their greatest challenges are yet to come. □



BOARCROC This 20-foot-long meat-eater—its prey likely included dinosaurs—had an armored snout it could use for ramming and three sets of fangs for slicing. Eye sockets turned forward enhanced stereoscopic vision to aid in hunting; large, well-developed muscles gave the jaw extra biting power.

STRANGE CROCS OF THE SAHARA

SINCE THE 1990s, with my teams of researchers and students, I have combed the Sahara for evidence of creatures great and small that lived with the dinosaurs.

My recent expeditions have revealed a treasure trove of crocs that populated Gondwana—the landmass that comprised today's southern continents—some 110 million years ago. Some were plant-eating dwarfs, others dinosaur-eating giants. Now their fossilized bones poke from parched Saharan landscapes, from windswept cliffs in Morocco to barren dune fields in Niger.

In some ways the fossils we have found remind me of the crocodilians alive today. All had textured skull bones and slow-growing body armor that absorbed heat while the animals basked in the sun. Some resemble mammals, with erect limbs for fleet-footed pursuit of prey on land; teeth divided into incisors, canines, and postcanines; and forward-pointing eyes. Nicknames for the monstrous BoarCroc (left) and the more diminutive three-foot-long RatCroc, DogCroc, and DuckCroc (right) capture those likenesses.

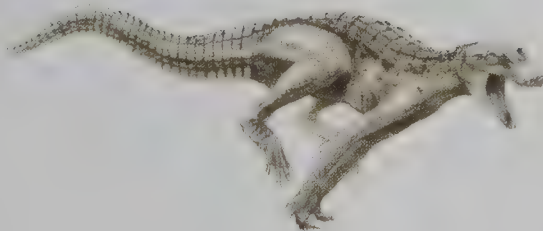
So what were the lifestyles of these creatures? Were they landlubbers, or were they predominantly aquatic like their kin, the crocs that remain today? I found a clue on a trip to northern Australia. The freshwater crocs there run so fast they actually gallop. At full speed on land they move in a sinuous, up-and-down motion like a running mammal. At water's edge their tails suddenly start to move side to side like a fish, propelling them underwater.

I closed in on a new perspective. My African crocs appeared to have had both upright, agile legs for bounding overland and a versatile tail for paddling in water. Perhaps that lay at the crux of their evolution and drove the explosion of Cretaceous crocs across Gondwana that began some 145 million years ago.

Under the noses of the dinosaurs, crocs evolved into ferocious predators and pint-size plant-eaters with a dual locomotor capability, best seen today in Australia's freshwater crocs. A distinctive survival strategy had emerged that even a monstrous asteroid could not completely erase. —Paul Sereno



RatCroc: A pair of buckteeth in the lower jaw may have allowed this croc to burrow in the ground for tubers.



DogCroc: With differentiated teeth and a soft nose pointing forward, this omnivore may have escaped from predators on its lanky legs.



DuckCroc: A broad, overhanging snout and hook-shaped teeth may have helped this croc catch small fish or worms in shallow water.



WHEN CROCS ATE DINOSAURS

Some 110 million years ago precursors of today's crocodiles ruled Earth. Explorer-in-Residence Paul Sereno brings a lost Cretaceous world to life on **National Geographic Channel, November 21 at 9 p.m. in the U.S.**

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An avid traveler and horticulturist, John McCallister was introduced to National Geographic when his aunt sent him a gift subscription to the magazine in the 1940s. "I like everything about National Geographic, what it stands for, and what it accomplishes," John says.

Now retired, John spends his time taking continuing education classes, landscaping his garden, and frequenting art museums, theatre performances, and concerts. John made a bequest gift as a way to support the things he holds dear. "I included National Geographic in my will because I want the Society to be around for future generations," he says.

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ON ASSIGNMENT **Scenes From Syria** Taking a picture of himself in a mirror provided a moment of levity for Ed Kashi (above) in Syria. Much of the rest of his time there, things were more tense. “Our driver had been questioned about who I was,” says the photographer, who also recalls being followed by a mysterious white Peugeot one afternoon. Kashi spent nearly five weeks with *National Geographic* Senior Editor Don Belt covering the



Society Updates



Since World War II, the National Geographic Society has given custom map cabinets to every President of the United States. President Barack Obama (above, with White House staffer Phil Schiliro) received his in the Oval Office in June.

A team of experts goes to unprecedented lengths to learn about the world's largest predatory fish in *Expedition Great White*. Tune in to the National Geographic Channel on November 16 at 9 p.m. for a close-up of the mighty shark.

The Holy Land takes readers to the birthplace of three great faiths: Judaism, Christianity, and Islam.



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Amish mantle and miracle invention help home heat bills hit rock bottom

Miracle heaters being given away free with orders for real Amish fireplace mantles to announce the invention that helps slash heat bills, but Amish craftsmen under strain of Christmas rush force household limit of

Save money: only uses about 9¢ electric an hour; so turn down your thermostat and never be cold again

By MARK WOODS
Universal Media Syndicate

(UMS) Everyone hates high heat bills. But we're all sick and tired of simply turning down the thermostat and then being cold.

Well now, the popular HEAT SURGE® miracle heaters are actually being given away free to the general public for the next 7 days starting at precisely 8:00 a.m. today.

The only thing readers have to do is call the National Distribution Hotline before the 7-day deadline with their order for the handmade Amish Fireplace Mantle. Everyone who does is instantly being awarded the miracle heater absolutely free.

This is all happening to announce the HEAT SURGE Roll-n-Glow® Fireplace which actually rolls from room-to-room so you can turn down your thermostat and take the heat with you anywhere. That way, everyone who gets them first can immediately start saving on their heat bills.

Just in time for winter weather, portable Amish encased fireplaces are being delivered directly to the doors of all those who beat the deadline.

These remarkable fireplaces are being called a miracle because they have what's being called the Fireless Flame™ patented technology that gives you the peaceful flicker of a real fire but without any flames, fumes, smells, ashes or mess. Everyone is getting them because they require no chimney and no



GENUINE AMISH MANTLES MADE IN THE USA: Everyone wants to save money on heat bills this winter, so entire Amish communities are working from the crack of dawn to finish. These fine real wood Amish made fireplace mantles are built to last forever. The oak mantle is a real steal at just two hundred ninety-eight dollars because all those who beat the deadline by calling the National Hotline at 1-866-815-7004 to order the fireplace mantles are actually getting the imported hi-tech Fireless Flame HEAT SURGE miracle heaters for free.

vent. You just plug them in.

The Fireless Flame looks so real it amazes everybody because it has no real fire. So what's the catch? Well, soft spoken Amish crafts-



JUST ANNOUNCED: The Heat Surge miracle fireplace has earned the prestigious Good Housekeeping Seal. The product has earned the Seal after evaluation by the Good Housekeeping Research Institute.

men who take their time hand building the mantles have a process that forces a strict household limit of 2 to keep up with orders.

"We can barely keep up ever since we started giving heaters away free. With winter just around the corner, everyone's trying to get them. Amish craftsmen are working their fingers to the bone to be sure everyone gets their delivery in time for Christmas," confirms Frederick Miller, National Shipping Director.

"These portable Roll-n-Glow Fireplaces are the latest home decorating sensation. They actually give you a beautifully redecorated room while they quickly heat from wall to wall. It's the best way to dress

up every room, stay warm and slash your heat bills all at the same time," says Josette Holland, HGTV Makeover Expert.

And here's the best part. Readers who beat the 7-day order deadline are getting their imported hi-tech miracle heaters free when encased in the Amish handmade real wood fireplace mantles. The mantles are built in the heart of Amish country where they are beautifully hand-rubbed, stained and varnished.

You just can't find a better made Amish fireplace mantles like this in the national chain stores. That makes the oak mantle a real steal for just two hundred ninety-eight dollars since the e-

HEAT SURGE™ Fireless Flame™

How It Works: The HEAT SURGE miracle heater is a work of engineering genius from the China coast so advanced, you simply plug it into any standard outlet. It uses only about 9¢ of electric an hour on the standard setting. Yet, it produces up to an amazing 5,119 BTU's on the high setting. So watch out, a powerful on board hi-tech heat turbine instantly forces hot air out into the room from the vent so you feel the bone soothing heat instantly. It even has certification of Underwriters Laboratories coveted UL listing. It also comes with a limited full year replacement or money back warranty less shipping plus a 30-Day Satisfaction Guarantee. OH and FL resident transactions require the remittance of applicable sales tax. Sorry no shipments to MA residents.



LISTED: E322174



Hot air only
comes out of
the top vent

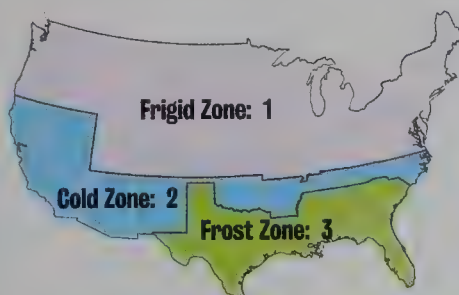
The hi-tech silent
heat turbine takes
in cold air

How to get 2 free heaters

The National Toll Free Hotlines are now open. All those who beat the 7-day order deadline to cover the cost of the Amish made Fireplace Mantle and shipping get the HEAT SURGE miracle heater free.

A strict limit of 2 per household has been imposed. Since some home woodworkers want to build their own mantle piece, they are letting people get the imported miracle heater alone for just \$249. Or, with the Amish made mantle you get the miracle heater free.

Use the map below to locate the weather zone you live in and call the Hotline number for your zone.



Claim Code: FP9687

EVERYONE LIVING IN THE
Frigid Zone: 1
START CALLING AT
8:00 A.M. TODAY
1-866-815-7004

EVERYONE LIVING IN THE
Cold Zone: 2
START CALLING AT
8:30 A.M. TODAY
1-866-815-7110

EVERYONE LIVING IN THE
Frost Zone: 3
START CALLING AT
9:00 A.M. TODAY
1-866-815-7112

FOR HEAT SURGE, LLC 8000 FREEDOM AVE., N. CANTON OH 44720

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ON THEIR WAY: Christmas orders have turned country roads into pipelines to the big city delivery system. Everybody wants a fireplace that comes fully assembled with a hand-made Amish mantle in oak or cherry finish and gets delivered by truck right to your door. All you do is plug it in.

of the miracle heater is
e.
his free giveaway is the
t way to slash heating
s and stay warm this
and winter. The HEAT
RGE Roll-n-Glow Fire-
ce gives you zone heat-
and all the beauty and
mth of a built-in fireplace
rolls from room-to-room
t can also save you a ton
money on heating bills.
ven people in California
l Florida are flocking to
them so they may never

have to turn on their fur-
nace all winter. And since
it uses only about 9 cents
of electric an hour on the
standard setting, the poten-
tial savings are absolutely
incredible.

"We are making sure no
one gets left out, but you bet-
ter hurry because entire com-
munities of Amish crafts-
men are straining to keep
up with demands. For now,
we are staying out of the
large national retail stores in
order to let readers have two

per household just as long as
they call before the dead-
line," confirms Miller.

It's a really smart decision
to get two right now because
for only the next 7 days you
get both miracle heaters
free. That's like putting five
hundred bucks right in your
pocket and you can save
even more money on your
monthly heating bills.

"Everyone's calling to get
one but those who are get-
ting their Christmas shop-
ping done are surprising

the whole family by get-
ting two. So when lines are
busy keep trying or log onto
amishfireplaces.com. We
promise to get to every call.
Then we can have a deliv-
ery truck out to your door
right away with your beau-
tiful Heat Surge Roll-n-Glow
Fireplace," Miller said.

"You'll instantly feel bone
soothing heat in any room.
You will never have to be
cold again," he said.

On the worldwide web:
www.amishfireplaces.com

Rolls anywhere to throw an instant heat wave with no chimney, no vents, no wood and no smoke



**EASILY ROLLS ANY-
WHERE:** This is the portable
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silently rolls from bedroom
to living room to keep you
warm. No vents, no chimney
and no tools. Just plug it in.



SAVES ON BILLS: Every-
one can get low bills and
stay warm and cozy. The
Roll-n-Glow Fireplace saves
a ton of money and makes
your front room look like a
million bucks.



SAFE FLAME: The Fireless
Flame looks so real it fools every-
one but there is no real fire. That
makes the flame window safe to
the touch under the watchful eye
of a parent. It's where the kids will
play and the cat and dog will sleep.



FREE: Get this \$249 miracle
heater free. It is being given
away free to all who beat the
7-day order deadline for your
choice of the oak or cherry
finish Amish Mantles. The free
heater comes already encased



Abridged An ancient Roman bridge spanned the Wadi al Murr near Mosul, Iraq, in the 1920s. Credited to German archaeologist Max von Oppenheim, this image never ran in the *Geographic*—nor did his manuscript for a story about his work at Tell Halaf, Syria, found with it in the photographic file. Von Oppenheim discovered the site (which dates from the sixth millennium B.C.) in 1899 and conducted excavations there over the next three decades. He shipped several treasures from the dig home to Berlin for exhibition in his personal museum, but many were destroyed in an Allied bombing raid in 1943. Objects salvaged from the rubble have recently been restored and are scheduled to go on display next year. —Margaret G. Zackowitz

📌 **Flashback Archive** Find all the photos at ngm.com.

PHOTO: MAX VON OPPENHEIM, NATIONAL GEOGRAPHIC STOCK

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Telephone _____ eMail _____

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Account No. _____ Exp. Date _____

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☐ My check is enclosed.

Smile Train-Dept. Mag.

P.O. Box 96211

Washington, DC 20090-6211

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Donate online: www.smiletrain.org or call: 800-932-9541

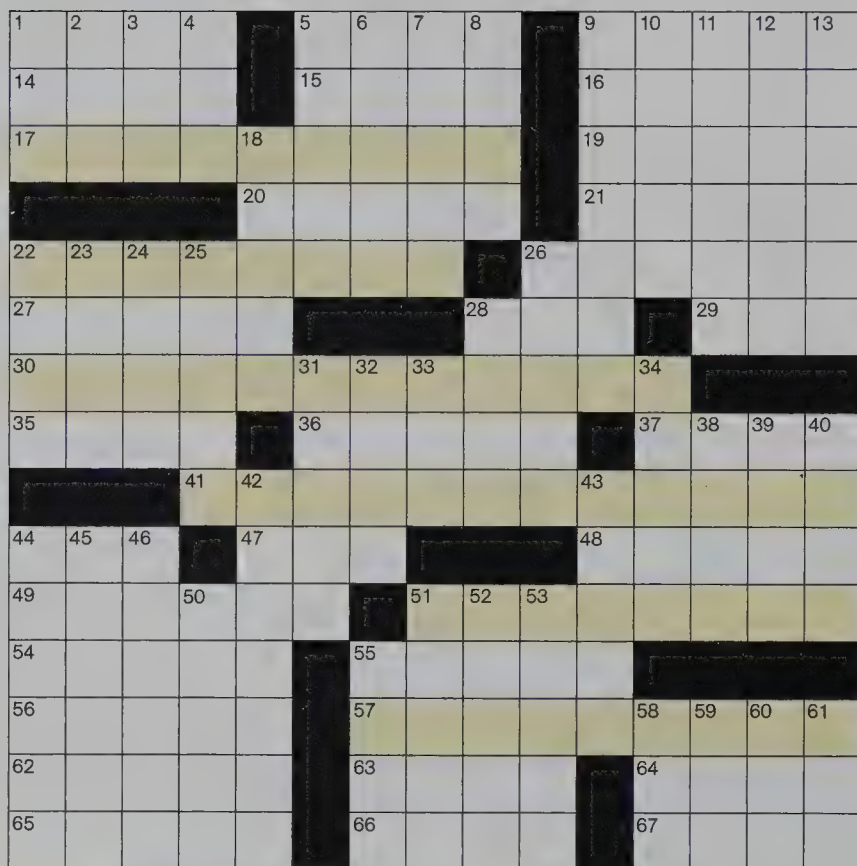


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Changing The World One Smile At A Time.

A Healthy Diet During Pregnancy Can Help Prevent Birth Defects And Clefts. Diet is an important part of pregnancy. Eat a healthy diet that contains lots of fruits and vegetables and foods fortified with folic acid. According to the U.S. Government, women who plan to have a child should be sure to take sufficient levels of folic acid (400 micrograms per day) during pregnancy to help prevent neural tube defects and reduce the risk for cleft lip and palate. When folic acid is taken one month before conception and throughout the first trimester, it has been proven to reduce the risk for neural tube defects by 50 to 70 per cent. Be sure to receive proper prenatal care, quit smoking, and follow your health care provider's guidelines for foods to avoid during pregnancy. For more information, visit www.SmileTrain.org. The Smile Train is a 501 (c)(3) nonprofit recognized by the IRS, and all donations to The Smile Train are tax-deductible in accordance with IRS regulations. © 2009 The Smile Train.

GEOPUZZLE



Bound for Glory

Puzzle by Cathy Allis

Ancient Egyptians' ties to animals (a scene on a sarcophagus is at left) extended even to the afterlife. Creatures were wrapped in linen or papyrus to serve as a human mummy's best friends. Read the animal mummies story on page 30. Then unravel the tinted clues.

ACROSS

- 1 Medium of 1932's *The Mummy*
- 5 Go the distance
- 9 Kvetches
- 14 Figment
- 15 George S. Kaufman collaborator Ferber
- 16 *Silas Marner* author George
- 17 With 22 Across, animal mummy parts?
- 19 Nick of 48 Hrs.
- 20 Figure skating category
- 21 Eighth Greek letter
- 22 See 17 Across
- 26 Examined a mummy, in a way
- 27 Book before Joel

- 28 *Jungle Book* python
- 29 Ones tapping IRAs
- 30 It transports natron to bunny mummifier Ikram
- 35 Like the wind in a Shelley ode
- 36 Map detail
- 37 British mil. awards
- 41 Feature of some well-preserved cat mummies found in an 1888 dig?
- 44 "Help wanted!"
- 47 Anti's cry
- 48 A counting rhyme's start
- 49 Clanlike
- 51 "Here Comes Peter Cottontail," for his mummy experimenters?

- 54 Craft carrying crude
- 55 Don, the longtime Dolphins coach
- 56 Kingdom
- 57 One performing a mummification step on a cottontail's kin?
- 62 Newbery-winning author Madeleine L'___
- 63 Wing-shaped
- 64 River that was a battle site in 38 Down
- 65 Jousting's mount
- 66 Prepare frankincense for sealing mummies, e.g.
- 67 Give off

DOWN

- 1 Looking buff
- 2 Gilbert and Sullivan princess
- 3 Part of a Waikiki welcome
- 4 Function or practice prefix
- 5 King Arthur adversary Morgan ___
- 6 Tricking with moisture
- 7 Quickly downed shot
- 8 Skye caps
- 9 Component of CPU
- 10 Part of a Waikiki welcome
- 11 Poet James Whitcomb and kin
- 12 Craftsperson at a wheel
- 13 Positions usually held by others
- 18 Jack whose wife ate fat
- 22 Soften before serving
- 23 Running wear?
- 24 Sp. fem. "those"
- 25 Gaels and Bretons
- 26 Hobby knife "handle"
- 28 Ukraine capital whence a chicken dish name
- 31 Rapidly spreading, as marketing
- 32 A deadly sin
- 33 Confucian philosopher Chu ___
- 34 Outer limits
- 38 ___-Japanese War
- 39 *Havana* actress Lena
- 40 Retired plush buddy of Rex and Bronty
- 42 Having no piece?
- 43 Give new cushioning
- 44 Big boxes, perhaps
- 45 Show the ropes
- 46 Fodder that's stored
- 50 Southern ball standout
- 51 Baleen is one type
- 52 Countrified
- 53 It may be amber or red
- 55 Mud wrapped as a mummy, for instance
- 58 Ingredient in a wet or dry toast?
- 59 Thanksgiving tuber
- 60 Inventor Whitney
- 61 Dirt road indentation

Answers in
Inside Geographic

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What do flip-flops have in common with the most innovative full-size sedan in America?*

Both were created by a desire for change.

The all-new Ford Taurus is one of the many products of change from Ford – with innovations like available radar technology that alerts you when sensors detect vehicles in front of you, behind you and in your blind spots.

The flip-flops? Part of the Ford Warriors in Pink® line of wear and gear for men and women available at fordcares.com. 100% of the net proceeds goes to Susan G. Komen for the Cure®. With over 15 years as a National Sponsor, Ford has dedicated more than \$100 million to help find a cure for breast cancer. A change we'd all like to see.



WARRIORS IN PINK
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Enter for a chance to win the All-New Ford Taurus. The most innovative full-size sedan in America.* Visit marthastewart.com/warriorsinpink.

NO PURCHASE NECESSARY. Contest begins 9/15/09 and ends at 11:59:59 p.m. Eastern Standard Time on 12/15/09. To enter, go to www.marthastewart.com/warriorsinpink and complete the official online entry form as directed. Contest open to legal residents of the 48 contiguous United States and the District of Columbia, aged 18 years or older at the time of entry. Void where prohibited. See official rules at www.marthastewart.com/warriorsinpink. One (1) Grand Prize of a 2010 Ford Taurus will be awarded, valued at up to \$41,995 (taxes, destination, handling and dealer fees paid). The Sponsor of this Contest is Martha Stewart Living Omnimedia, Inc., 11 West 42nd Street, New York, NY 10036. *Based on total number of first-in-class features. Class is full-size non-luxury sedans.

NATIONAL GEOGRAPHIC



Are We Alone?

SEARCHING THE HEAVENS
FOR ANOTHER EARTH

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Conversations for a Smarter Planet

A mandate for change is a mandate for smart.

The world is ready for change – that much is clear.

For leaders of all kinds, this moment presents a rare opportunity. Our planet is not just getting smaller and flatter. It is also becoming smarter. And that means we have the potential to change the way the world literally works.

Computational power is now being put into things we wouldn't recognize as computers – cars, appliances, cameras, roadways...even pharmaceuticals and livestock. We are interconnecting all of this through the Internet, which has come of age. And we are applying powerful new systems and sophisticated analytics to turn oceans of data into insight, knowledge and intelligence.

Consider the changes already under way.

Smart traffic systems are helping to reduce gridlock by 20%, cutting pollution and increasing ridership on public transit.

Smart food systems based on RFID technology embedded into supply chains are monitoring meat, poultry and other items from the farm to the super-market shelf.

Smart healthcare systems are helping to lower the cost of therapy by as much as 90%.

Police departments are correlating street-level information from myriad observations and devices to identify crime patterns – helping prevent crime, rather than simply punishing it.

The list is long, and the transformation is just beginning. Its benefits will be reaped not only by large enterprises, but also by mid-sized and small companies – the engines of economic growth everywhere – and by individuals and communities around the world.

Imagine how a smarter planet will transform *all* the things we seek. The ways we pursue economic growth, societal progress, environmental sustainability and cures for disease. The way we interact with each other and with the world.

The opportunity is before us, and the moment will not last forever. Will we seize it? As we look to stimulate our economies and rebuild our infrastructure, will we simply repair what's broken? Or will we prepare for a smarter future?

Join us at **ibm.com/smarterplanet**



His dreams changed a valley.

His wines changed a country.

Robert Mondavi transformed Napa Valley, crafting wines that stand among the best in the world. Then he took all he knew to Woodbridge, CA, to make affordable wines for every day. Because every table deserves the joy of great wine.

His name is on the bottle. His story is in it.

by Robert Mondavi



NATIONAL GEOGRAPHIC

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- The Other Tibet** **30** The Uygurs of China's oil-rich far west are facing a crisis.
By Matthew Teague Photographs by Carolyn Drake
- Resurrection Island** **56** Once a scene of slaughter, South Georgia is awash with life.
By Kenneth Brower Photographs by Paul Nicklen
- Searching for New Earths** **78** Distant worlds are being discovered. Is one of them like ours?
By Timothy Ferris
- The Hadza** **94** Tanzania's hunter-gatherers live 10,000 years in the past.
By Michael Finkel Photographs by Martin Schoeller
- The Mating of Plants** **120** Let's not be coy: Pollen is plant sperm, and it's born to ride.
By Rob Dunn Photographs by Martin Oeggerli
- Monks of Mount Athos** **134** They can be zealous, reclusive, worldly, prayerful, defiant.
By Robert Draper Photographs by Travis Dove



PAUL NICKLEN

Typically a scavenger, the northern giant petrel incessantly pecked the photographer and his camera with its big beak. Story on page 56.

Look Who Saw the Bigger Picture

The winners are announced!

Thousands of fantastic entries... a world of amazing subjects... eight inspiring winning shots... one huge understanding of biodiversity... we're delighted to announce the winners of *The Green Wave* kids photography contest – 'See the Bigger Picture'.

A world of amazing connections

Aircraft manufacturer Airbus is determined to help protect biodiversity. It encourages everyone to take responsibility and take action. That's why it's supporting the United Nations Environment



The judges considered composition, creativity and relevance to biodiversity. They included Joel Sartore,

National Geographic photographer, renowned for photographing endangered species to highlight the problems of biodiversity loss. "The spectacular variety of life on Earth keeps our planet healthy and balanced. When we lose species we lose connections and that can trigger chain reactions. In parts of the world, for example, bees have vanished so people have to hand-pollinate vegetables with feathers. Our children will inherit a world rich – or poor – in biodiversity based on how much we preserve and protect today."



USA & Canada winner 'Ecolife'

"This photo was taken at the National Arboretum. Its relevance to biodiversity is that amphibians, such as frogs, are endangered but they are a very important part of an ecosystem."

Prerona Kundu,
age 11, USA



USA & Canada winner 'Banana Slug Dining'

"This banana slug was at our campsite in Redwood National Park. They are important to the environment as they eat decomposing material (and raspberries!) and help to fertilize the soil."

Anthony Avellano,
age 12, USA

See the bigger picture yourself

The lucky winners are visiting the National Geographic Society's landmark headquarters in Washington, D.C. They will meet Joel Sartore for expert photo tips first-hand before attending an exclusive gala event. Twenty honorable mentions are also receiving National Geographic goody bags.

Take a look at all these exciting entries on

www.seethebiggerpicture.org

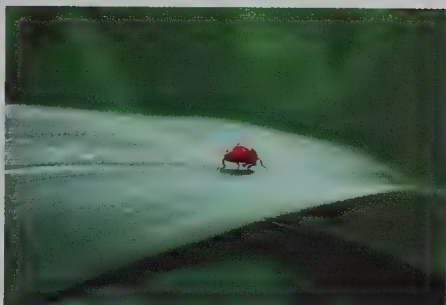


'Orang Utan'

"The baby of Orang Utan is hungry and needs love."

by **Vinzent Raintung**,
age 8, Germany

Airbus winners



'Lonely Ladybug'

"This year we had an unusual abundance of ladybugs, which shows how sensitive the population reacts to changes of the environment."

by **Julia Kresse**, age 15, Germany



'Shargacucullia Lychnitis'

"We were walking in Aveyron when we saw this. My dad had to hold the flower for me to take the photo because of the wind."

by **Clémence Bonnefous**,
age 8, France

Programme's *The Green Wave*, a youth outreach and education initiative run by the Convention on Biological Diversity; *The Green Wave* encourages young people to learn about the complex variety of life on Earth and its role in building a sustainable future, so the 'See the Bigger Picture' competition asked them to take photographs that show what biodiversity means to them. The standard of entries was as impressive as the response—from the U.S. to Belgium and from the Maldives to Ecuador—the world's children showed how much they care about the planet and about their future.



International winner 'Spirit of the Bottle'

"Most of the people are careless and they throw all kind of trash all over the place, awful! However, this animal is a really clever one; it benefits this trash quite nifty. It has made its home in to this bottle top."

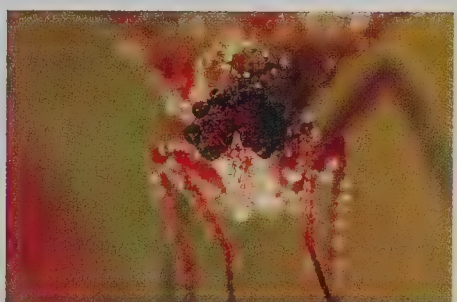
Alex Marttunen,
age 11, Finland



International winner 'Dominican Lizard'

"3 colors (in 1), 2 plants, 1 life I took this in my back yard!"

Chad Nelson,
age 12, Dominican Republic



International winner 'Macroworld'

"Macroworld is the most interesting subject of photos. We can find there the best specimens. In this picture we can see a sleepy fly with lots of drops."

Patryk Majchrzak,
age 16, Poland



**NATIONAL
GEOGRAPHIC**



UNEP

THE GREEN WAVE

One school, one tree, one gift to nature



CBD



AIRBUS

NATIONAL GEOGRAPHIC

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Visions of Earth 10

CULTURE

Merry Krampus

St. Nick's devilish companion is making a comeback in parts of Germany and Austria.

GEOGRAPHY

Sign Language

Public signs reveal local color, from "sleeping policemen" to beloved bugs.

HEALTH

Fighting the Flu

Would quarantine and isolation help in the effort to stem the H1N1 strain?

SCIENCE

Words That Last

The terms for "I," "two," "three," "five," and "who" have been around for millennia.

HISTORY

Digital Scripture

The pages of a fourth-century Bible are reunited on the Internet—scars and all.

THE BIG IDEA

The Carbon Bathtub 26

It will take a very long time to drain excess CO₂ from Earth's atmosphere.

Inside Geographic 150

Year in Review 152

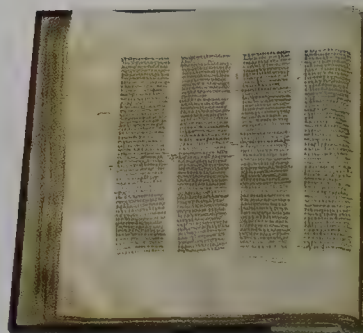
Flashback

GeoPuzzle

On the Cover

The image of newly discovered planet Gliese 581 e is based on data showing it has about twice the mass of Earth.

Art by Dana Berry



ngm.com



Best Pictures of 2009

Take an e-stroll through galleries of the top ten photos of the year from the magazine, selected by Editor in Chief Chris Johns, as well as the ten most popular Your Shots.

JAMES NACHTWEY

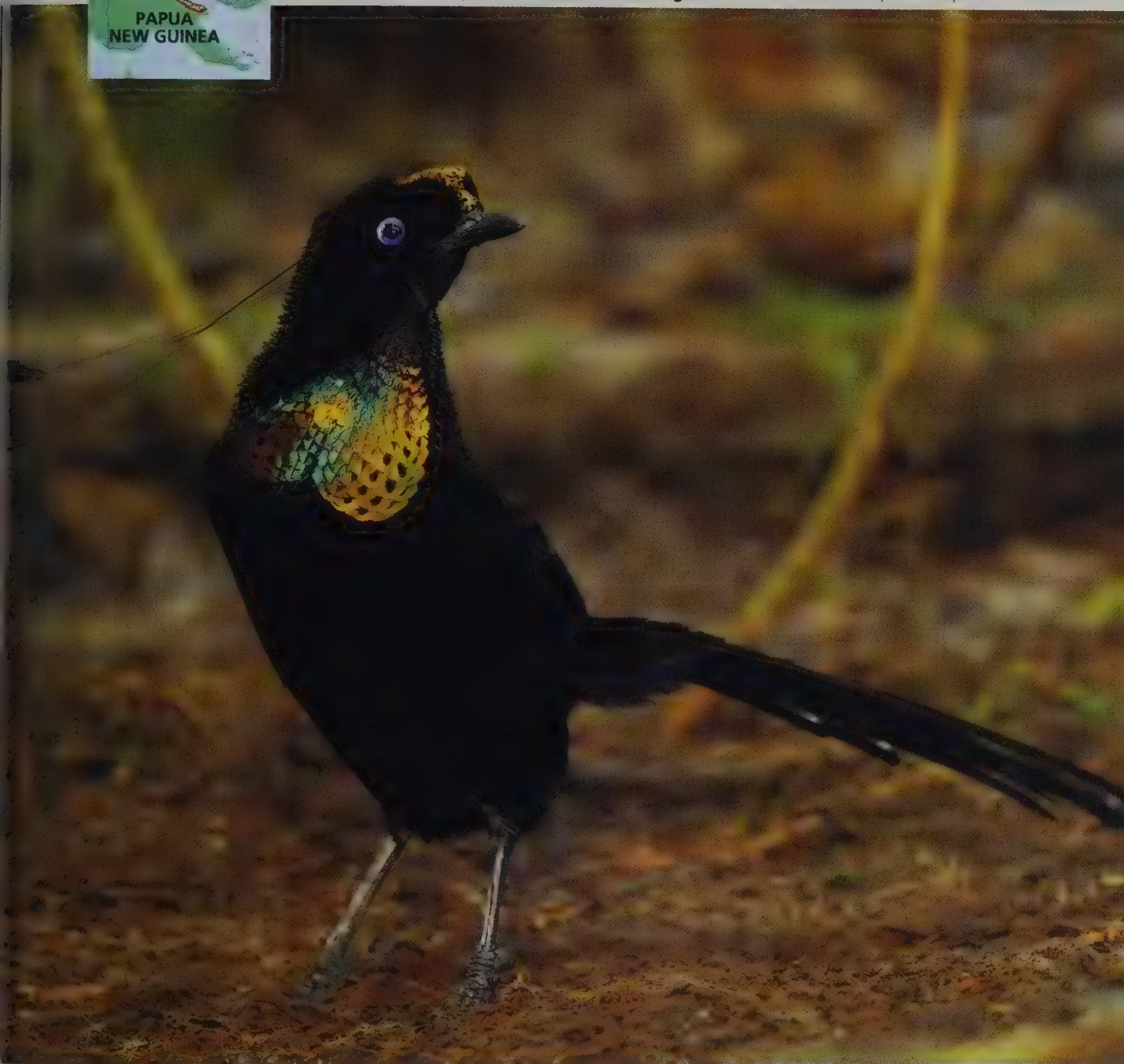
Pacific Ocean



Wahnes's Parotia (*Parotia wahnesi*)

Size: Head and body length, 36 - 43 cm (14.2 - 16.9 inches); wingspan, approx. 41 cm (16 inches)

Weight: 144 - 172 g (5.1 - 6.1 oz) **Habitat:** Mid-montane forest in a small section of the northern coastal mountain ranges of Papua New Guinea **Surviving number:** Estimated at 2,500 - 10,000



Photographed by Tim Laman

WILDLIFE AS CANON SEES IT

All the world's a stage. The male Wahnes's parotia makes the most of his starring role as he performs his "ballerina dance" for an audience of females. This courtship display takes its name from the way he positions his flank plumes around his body, resembling a tutu. He simultaneously bows and fans his tail, steps side to side, shakes his feathers, and shakes his six wire-like head plumes in a flashing, iridescent spectacle. Females, meanwhile,

follow the action from a perch, sometimes fluttering or twitching their wings. But the world is getting smaller for this theatrical bird, as habitat loss steadily erodes its already limited territory.

As we see it, we can help make the world a better place. Raising awareness of endangered species is just one of the ways we at Canon are taking action—for the good of the planet we call home. Visit canon.com/environment to learn more.

Canon



Writer Matthew Teague photographed these Uyghur men, advancing upon Chinese forces, moments before they were shot.

Many people carry cameras these days. Some have uncommon courage. On page 36 of this issue, in the story “The Other Tibet,” there is a photograph taken with a cell phone. The photographer was not a professional. She was a Uyghur woman who documented the shooting of a Uyghur man by Chinese security forces on a street in Urumqi, capital of China’s Xinjiang region. She later gave the picture to *National Geographic*’s photographer Carolyn Drake.

Like their Tibetan neighbors, the Uyghurs have a history of struggle, but when Carolyn began covering them more than a year ago, she had no idea that the conflict would explode into one of China’s most deadly uprisings since the Tiananmen Square massacre in 1989. By June of this year, she thought her coverage was finished; she returned home to Istanbul. Then hints of unrest began to filter back to her. “At first I didn’t realize the severity of it. I started sending emails to my translator and friends in Kashgar, Hotan, and Urumqi, but no one responded.” She anxiously searched news sources, but the picture of what was going on seemed incomplete and unclear. There was only one way to find out: return to China. She did so in July.

Carolyn, writer Matthew Teague, and a Uyghur woman with a cell phone camera all took great risks to bring us the story of a struggle for human rights. Many people carry cameras these days. Sometimes they help us find the truth.

Chris Schuss

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the sustainable management of species



Main achievements

- Over 44,000 houbara bred in captivity - from 165 in 1997 to 16,624 in 2009.
- Over 30,000 houbara released into the wild in Morocco.
- Large scale ecological studies - 40,000 km², 1,500 radio-tagged birds - enabling the design of effective in-situ conservation actions.
- Hundreds of jobs created and local infrastructure upgraded by investment projects. The Promise of Sustainable Development.

The Emirates Center for Wildlife Propagation (ECWP) in Missour, Morocco, was the brainchild of Sheikh Zayed Bin Sultan Al Nahyan, late President of United Arab Emirates. A passionate conservationist, he founded the center in 1995 as part of a pioneering, visionary initiative to save and sustain the houbara bustard and preserve Arabic cultural heritage. In 2006, his strategy was secured by the Abu Dhabi Government when it created the International Fund for Houbara Conservation (IFHC), an umbrella organization for ECWP and other houbara conservation projects.

Mission

ECWP's founding mission was to restore and conserve North Africa's native houbara bustard populations through:

- A conservation breeding program
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- Sound ecological research to advance knowledge of the houbara
- Action to support local development and improve environmental education

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August 2009

Vanishing Venice

I just arrived back from Venice yesterday. Your article made me feel utterly guilty while also making me ponder the effect of tourism generally. Though Venice is a magical city, it was hard to not be distracted by the constant procession of tour groups who barged their way through the narrow streets. I felt as though I was in a pantomime and that Venice was merely a stage. The city appears to have succumbed to tourism. Some areas feel not at all genuine. The prices, while not as extortionate as in Rome, are in some cases ridiculous, with the price of a pint of beer reaching 12 euros [about \$17]. Though the response of closing Venice to deal with these problems seems clearly impossible, something serious must be done.

SAMUEL WOOD
Bruton, England

After taking the vaporetto for days in Venice, nothing surprised us more than catching one at closing time for the endless amounts of tourist shops. As we squished on that boat, my teen and I could barely breathe given the amount of

people traveling. We watched as the majority of these workers disembarked to take the train out of Venice. It felt like closing time at Disneyland, with Snow White taking her wig off. There is something about visiting a place that makes it seem more authentic when you know that people really live and work there—outside of the tourist trade. Maybe this is why people can spend weeks in Rome and only a few days in Venice.

LISA-ANN KIRK
Vancouver, British Columbia

You provided a wonderful sense of Venice's spirit, but I was surprised to see two fundamental issues omitted from the feature: Venice's ongoing wastewater-disposal problems and global warming's role in the increasing magnitude and/or frequency of *acqua alta* events.

TODD ANDERSON
San Francisco, California

Ever notice the color of the water in Venice canals? With 21 million visitors each year and 60,000 locals, maybe there are more things to worry about than high tides.

JOHN BATH
Ballina, New South Wales

My wife and I, after spending over half a century working, raising a family, and saving diligently, decided to take a postretirement "vacation of a lifetime." Guidebook in hand, we descended on Venice like a swarm of "locusts on the fields of Egypt." We had no idea we were so insensitive until we came home and read the latest bash of tourists in *National Geographic*. Until then, I did not have any more of a guilty

conscience than the waiter who charged us 30 euros [about \$44] for a Coke and a beer in the Piazza San Marco, which fortunately was not flooded at the time—perhaps because tourism was reported to be off considerably. Perhaps your editors can give us some hint as to where we thoughtless, destructive, careless tourists can share some of the privileges of your writers and photographers.

OTIS HEADLEY
Oneonta, Alabama

After reading your article on tourism and its impact on the Venetian people, I would like to add that many places are suffering a similar fate. I grew up in eastern North Carolina and still live here. It's one of the fastest growing states in the country, with tourism a major industry. Along with jobs and opportunities, tourism has brought higher property taxes, traffic, the loss of wildlife habitat, poor water quality, decreased access to the water, and increases in insurance. The only alternative for some is to leave the area where they have spent their entire lives to find a cheaper place to live.

BYRON BATEMAN
Farmville, North Carolina

Corrections, Clarifications

August 2009: Yellowstone
Page 68: Basaltic magma is trapped inside Yellowstone's magma chamber by less dense—not denser—overlying magma.

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Full of surprises.

LETTERS

Venice was built in the lagoon to help its residents escape invading tribes. Alas, the move was just a temporary solution, as modern marauders have overrun the place. *La Serenissima* must survive as a cultural and historical site. The regrettable loss of its inhabitants may stabilize, but only if the reality of what Venice has become is embraced and responsibly managed.

MICHAEL PRIOR
Oakland, California

As an architect who has been privileged to experience Venice, I can understand the sentiment to halt its decaying grandeur from the ravages of time and tides. However, as a member of the human race, I cannot help but wonder when Mayor

Cacciari or his successors will say *abbastanza* (enough) and allow the forces of nature to take over.

JONATHAN JEWITT
Glasgow, Scotland

As a Venetian, I enjoyed the article. However, I must say that I don't agree with the statement that "one thing the Venetians haven't abandoned is their cynicism." Not all Venetians are cynical. Most of us feel a deep love for our city and great respect for all our guests. Instead of cynicism, why not speak about the distinctive sense of irony that is so typical of Venetians? That is something about the Venetian philosophy of life that is never mentioned.

ERIKA ROMBOLOTTO
Venice, Italy

Under Yellowstone

Joel Achenbach's article about the Yellowstone supervolcano states that no supervolcano has erupted in recorded human history. However, New Zealanders are told that Lake Taupo, in the center of the North Island, is the collapsed caldera of a supervolcano that erupted approximately 26,500 years ago. A smaller eruption that occurred in A.D. 180 is believed to have turned the sky red over Rome and China, a phenomenon recorded at the time.

GORDON GILLESPIE
Taumarunui, New Zealand

Isn't She Lovely?

The article on camel beauty queens brought back fond memories of the ports I visited when I was deployed with the



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FROM THE BEST LAND COME

U. S. Navy during Desert Storm and the liberation of Kuwait. The ship made port calls in Oman, Bahrain, Abu Dhabi, Al Fujayrah, and Dubai. The most interesting experience was a visit to a camel ranch in Bahrain. I decided to have my picture taken with a camel. My face was about a foot away from this animal who wore a huge grin. But camels spit. She let loose with a wet one—which I took right in the face. Next time *National Geographic* goes back to the Arabian Peninsula, take me with you.

MAURY MIDDLETON, III
San Tan Valley, Arizona

I don't know what a really great-looking camel looks like. I thought I would find out by reading the camel pageant

story. Yet I reached the end of the story and saw nary a photo of the Miss Universe of the camel world. Sure, there were some camels shown, but no indication as to which was the beauty and which was just another beast. I think we deserved at least one shot of the belle of the ball wearing her crown, holding her scepter, and shedding the inevitable tears of a newly appointed queen.

RICK MIGGINS
Toluca Lake, California

Last December I journeyed throughout the Wadi Rum desert in Jordan atop a camel. They may have been beasts of burden in ancient times. Now we are able to appreciate these gentle giants. I am surprised

that the author did not take time to ride a camel. I, on the other hand, am researching the possibility of finding a camel-riding school for next year's vacation.

MIA VENSTER
Fort Lauderdale, Florida

I really have no interest in camels. However, on glancing through the article, I caught the words "beauty" and "lovely" and thought surely the author, Matthew Teague, had used the wrong words. I then had to read the entire article, which contained no condescension and no satire, and had a light touch of humor. I came away with respect for the beauty of this very functional beast.

MARJORIE OVELMEN
Boca Raton, Florida

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LETTERS

Kamchatka Salmon

While Kamchatka may have the first whole-basin Pacific salmon reserve, Alaska has a more advanced Sustainable Salmon Fisheries Policy. But both are under similar siege. I hope both governments will ultimately decide that "fish come first."

GEORGE MATZ
Fritz Creek, Alaska

The village of Khailino may be isolated, but its residents sure make an effort to keep in touch with the rest of the world. I noticed an interesting detail in the picture on pages 48-9. Behind the lineup of microwave dishes, a huge array of yagi antennas can be seen. This

means that this may be the home of a radio amateur who communicates worldwide with fellow hams by bouncing his radio transmissions off the moon (known as Earth-Moon-Earth, or EME). Due to highly sophisticated equipment and special technical and operational know-how, less than one percent of the world's radio amateurs are able to operate in this mode.

ERNST C. WILLERT
Niederkassel, Germany

The Big Idea: Shading the Earth

As a dermatologist, I'm all for sunscreens. But launching trillions of sun-deflecting disks

into space to combat global warming? I think most folks would call this unconscionable cosmic litter, the scope of which is simply beyond sanity. Changing human behavior means preaching less personal, institutional, and political greed. A competitive society equates success with acquisition and growth. Living within means, with an eye toward simple sustainability and with respect for the Earth? We need to go there: as families, as a country, and as a global community.

LISA A. PAWELSKI
Pittsburgh, Pennsylvania

This may sound like a good idea, but what are we going to

do when we need to get rid of the reflectors because of an impending ice age?

BILL MOULTON
Port St. Lucie, Florida

Bad idea. We can't even begin to clean up the space junk already around Earth. Of course, parking billions of reflectors somewhere like the inner Lagrangian point may sound slyly techy, but it could also interfere with the way we measure and learn about solar emissions, particularly storms that could kill our astronauts, damage our communications satellites and GPS, and fry our electrical grid. Intelligent use of what we already have on Earth is the wise way forward.

A. CANNARA
Menlo Park, California

If a cloud of reflectors is implemented to reduce the use of fossil fuels, what will we use to heat our homes on this cooler Earth? The cloud will reduce the effectiveness of solar energy, making it even more expensive. Cooler temperatures and less light will also reduce vegetation, reducing the biomass available for biofuels, not to mention food for the world's population. What's the big idea?

TIM AND JUDY NELSON
Jamestown, Tennessee

I was surprised that your article did not even mention ocean acidification, the evil twin of climate change. While it is true that there may be schemes to temporarily mask increasing temperatures, they will do

nothing to combat the problem of increasingly acidic oceans. About a third of our carbon dioxide emissions is absorbed by the oceans, making them more acidic. As ocean acidity increases, many species are threatened, especially those that build shells and skeletons out of calcium carbonate, such as corals, oysters, and mollusks. In fact, some scientists predict that coral reefs could be extinct by the end of the century if we do not reduce our carbon dioxide emissions. So, while geoengineering fixes like the one in your article might seem like an easy solution to this problem, the only true solution is to mitigate our carbon dioxide emissions.

ELLYCIA HARROULD-KOLIEB
Washington, D.C.



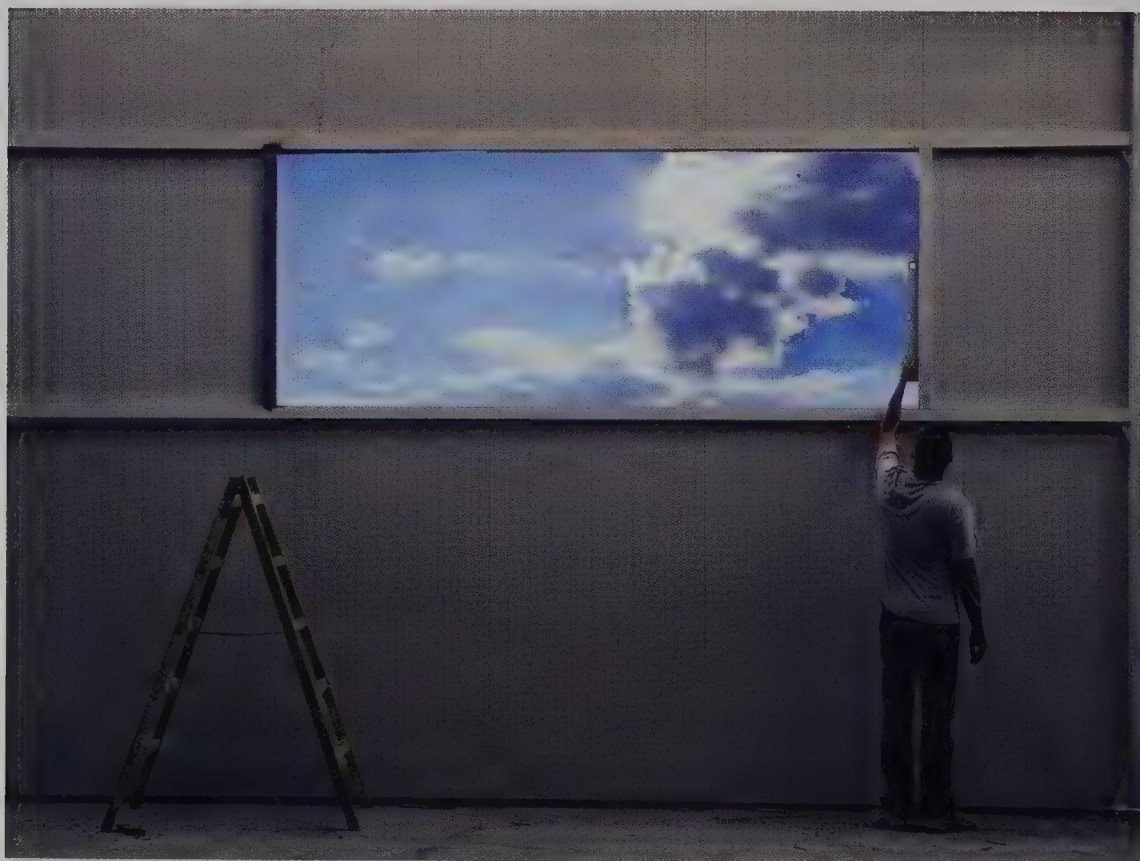
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EDITORS' CHOICE

Ivan Dobrev Sofia, Bulgaria

Dobrev usually takes nature pictures, but this time his job offered a window on the world. While building an industrial hall, the 32-year-old carpenter framed a stepladder, a colleague, and a dazzling burst of bright sky.

Melissa Fiene Sydney, Australia

Ten feet down in the blue Coral Sea, jacks and a jellyfish swim in sync. Capturing the "calm and surreal" sight was Fiene, 24, a marketer training to be a dive master. "I love the abstract nature of the underwater world," she says.



READERS' CHOICE

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Worlds Away Sorting through the hundreds of reader photographs submitted to Your Shot every day, we don't hear echoes—we see them. That silhouette of a proper Russian lady makes us think of that smoke-wreathed Indian holy man; a Berber's unfurled turban calls to mind the shot of an Israeli boy walking past an arrow scrawled on a door. Especially as we look at the pictures of people sent in from all over the world, similarities emerge.

Sometimes we find the echoes resonating in the subjects' actions, or in the rhythmic pattern of the photos' backgrounds. Sometimes it's something more subtle. We hope you'll see the echoes in the images on the following pages and that they make you want to look a little closer. —Margaret G. Zackowitz



Katerina Evseyeva Yakutsk, Russia

The autumn light, a bowl of apples, and her mother's shadow on the kitchen wall inspired Evseyeva, a 28-year-old NGO director, to pick up her camera while the two of them drank tea.



Soma Shekar Hyderabad, India

On a road trip with friends, "we chanced upon a small temple in Vishakhapatnam, India," says Shekar, 29, a software engineer. This sadhu "was enjoying his smoke, lost in his own world."



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Véronique Fleury
Montreal, Quebec

"I took this picture while I was on a trek in the Sahara desert," says Fleury. From a vantage point atop a dromedary camel, "I turned around just in time to see our guide tying his turban."

Jill Schneider
San Francisco, California

While traveling in Israel a year ago, Schneider, 27, who is pursuing a master's degree in photography, caught this Israeli boy walking in Jerusalem near the Western Wall.

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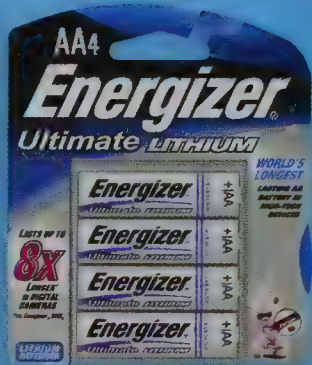


It was entered in that I ultimately chose a courageous bicycle rider forging ahead. The rider faced, but the photographer drew the line that captured the heart of the theme:

Hardison, National Geographic photographer and judge in the Energizer Ultimate Photo Contest

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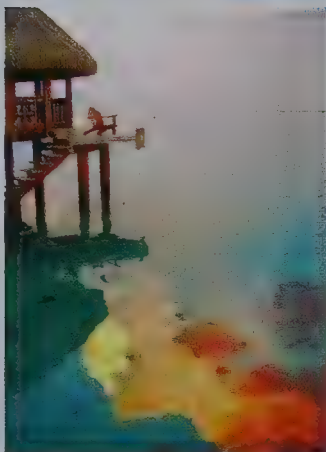
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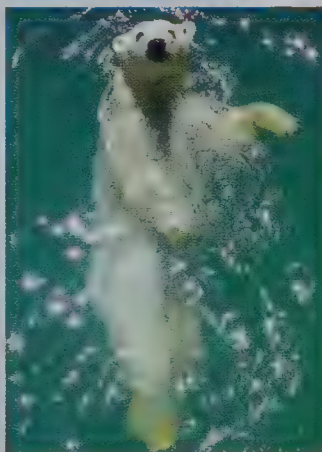
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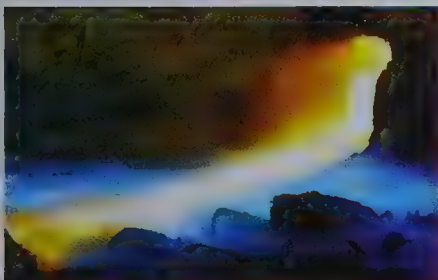
ANIMALS • WILDLIFE

**RUSTON
AGTE**
Tucson, AZ



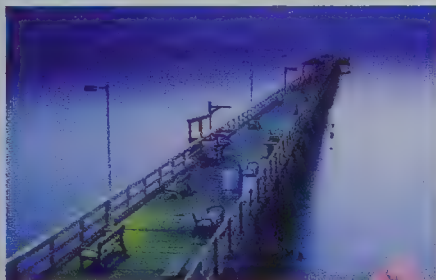
NATURE

**TRACY
HAGEN**
La Selva
Beach, CA



TRAVEL

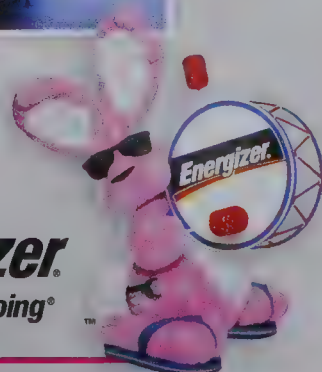
**GLENN
TRAVER**
Hanover
Township, PA



AND THE WINNER IS...

In the end, it was up to internationally acclaimed photographer, Jim Richardson, to select the grand-prize winner from this remarkable group of first-place finalists. **Turn the page** to see his selection and find out who's going on a 10-day National Geographic Expeditions trip for two to the Galápagos Islands.

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Gabriel Rif

Elat, Israel

Likely wearing a dress to preserve her modesty, the woman swimming in the Red Sea shallows “was on par with all the other colorful creatures of the coral reef,” says Rif, 38, who works as an underwater photographer for a diving center.



Melissa Speelman

Cincinnati, Ohio

Her new underwater camera housing got a workout this summer at the local pool, claims art teacher Speelman, 39. While her four-year-old son Owen “has always loved the water,” she says, “after seeing photographs of himself under water, I think he sprouted gills.”



Liam Neeson, UNICEF Supporter, actor

24,000

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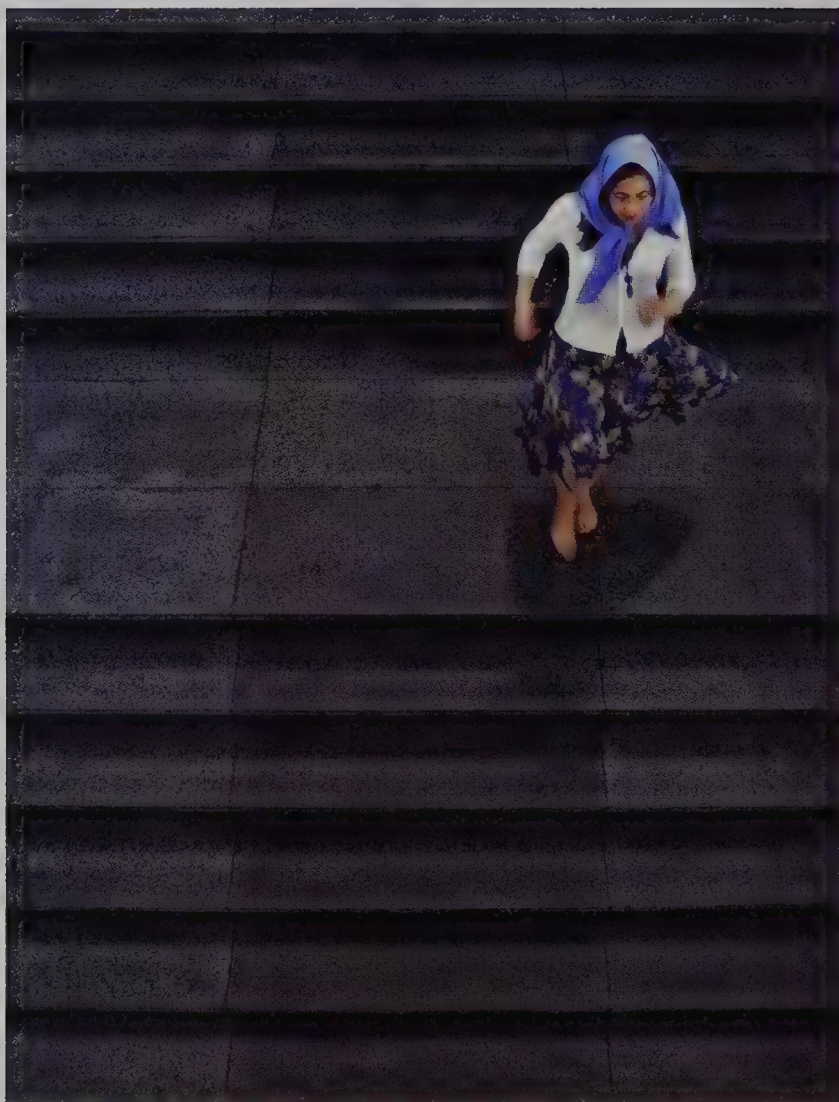
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YOUR SHOT | PEOPLE



Mat Zain Abdullah

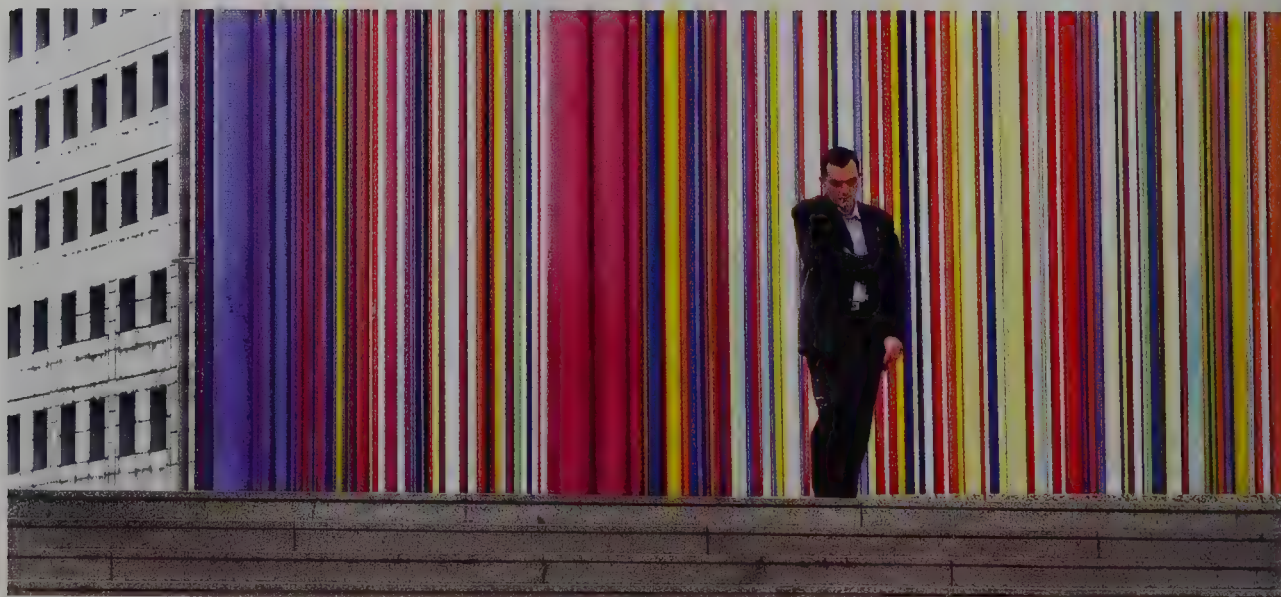
Petaling Jaya, Malaysia

Looking down from a balcony at the national mosque in Kuala Lumpur, the 38-year-old bank employee saw this woman leaving the building and got this shot.

Bruno Schlumberger

Ottawa, Ontario

The stripes of artist Raymond Moretti's "La Cheminée" shimmer behind a businessman in the section of Paris called La Défense. Schlumberger, 60, was born in France but works as a photojournalist in Canada.



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Kylie Peterson
Orem, Utah

Peterson, a 19-year-old dietetics major at Brigham Young University, caught her little brother Jens blue-footed in the act of playing hopscotch. "Give him a piece of chalk and a sidewalk, and he will be happy for hours," she says.

Pramod Bansode
Panvel, India

Monsoon winds steal the umbrella of boys playing in the rain—which stole the attention of Bansode, a dental surgeon. He snapped the shot outside the village of Kolkha in India's Maharashtra state.



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VISIONS OF EARTH



Japan Covered in chrome and gleaming neon, big rigs from across Japan shine at a truck show in Aichi Prefecture. Known as *dekotora*, most are working trucks—though on long hauls, they're typically not driven with all their lights on.

PHOTO: ROGER SNIDER



Antarctica Cliffs higher than a hundred feet mark the edge of the Ross Ice Shelf, a glacier-fed slab the size of France connected to the Antarctic coast. Fissure lines near the edge show where the next iceberg may calve.



PHOTO: DAVID BARR



Kosovo In the village of Donje Ljabinje, local tradition calls for painting a bride's face to ward off bad luck. After the ceremony, women from her new husband's family washed Rasima Biljibani's face clean.



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PHOTO: VALDRIN XHEMAJ, EPA/CORBIS



**IMAGINE THIS BLISTERING RASH
ALONG WITH STABBING PAIN**



**AND YOU'LL HAVE AN IDEA OF
WHAT IT CAN BE LIKE TO HAVE SHINGLES.**



For more information on the availability of ZOSTAVAX through the Merck Vaccine Patient Assistance Program, visit www.merck.com/merckhelps or call 1-877-9 SHINGLES.

IF YOU HAD CHICKENPOX AS A CHILD, YOU COULD GET SHINGLES NOW.

The chickenpox virus is still in your body.

It can resurface as Shingles, a painful, blistering rash. The Shingles rash usually lasts up to 30 days, and for most the pain lessens as the rash heals. But some people who develop Shingles experience long-term pain that can last for months, even years.

ZOSTAVAX is a vaccine that can help prevent Shingles.

ZOSTAVAX is used to prevent Shingles in adults 60 years of age or older. Once you reach age 60, the sooner you get vaccinated, the better your chances of protecting yourself from Shingles. ZOSTAVAX is given as a single shot. ZOSTAVAX cannot be used to treat Shingles, or the nerve pain that may follow Shingles, once you have it. Talk to your health care professional to see if ZOSTAVAX is right for you.

Important Safety Information

ZOSTAVAX may not fully protect everyone who gets the vaccine. You should not get ZOSTAVAX if you are allergic to any of its ingredients, including gelatin and neomycin, have a weakened immune system, take high doses of steroids, or are pregnant or plan to become pregnant. Possible side effects include redness, pain, itching, swelling, warmth, or bruising at the injection site, as well as headache. You are encouraged to report negative side effects of prescription drugs to the FDA. Visit www.fda.gov/medwatch or call 1-800-FDA-1088. Before getting vaccinated, talk to your health care professional about situations you may need to avoid after getting ZOSTAVAX. Please see the Patient Product Information on the adjacent page.

Before you get Shingles, ask about ZOSTAVAX.

ZOSTAVAX[®]
Zoster Vaccine Live

www.zostavax.com

Generic name: Zoster Vaccine Live

You should read this summary of information about ZOSTAVAX¹ before you are vaccinated. If you have any questions about ZOSTAVAX after reading this leaflet, you should ask your health care provider. This information does not take the place of talking about ZOSTAVAX with your doctor, nurse, or other health care provider. Only your health care provider can decide if ZOSTAVAX is right for you.

What is ZOSTAVAX and how does it work?

ZOSTAVAX is a vaccine that is used for adults 60 years of age or older to prevent shingles (also known as zoster).

ZOSTAVAX contains a weakened chickenpox virus (varicella-zoster virus).

ZOSTAVAX works by helping your immune system protect you from getting shingles. If you do get shingles even though you have been vaccinated, ZOSTAVAX may help prevent the nerve pain that can follow shingles in some people.

ZOSTAVAX may not protect everyone who gets the vaccine. ZOSTAVAX cannot be used to treat shingles once you have it.

What do I need to know about shingles and the virus that causes it?

Shingles is caused by the same virus that causes chickenpox. Once you have had chickenpox, the virus can stay in your nervous system for many years. For reasons that are not fully understood, the virus may become active again and give you shingles. Age and problems with the immune system may increase your chances of getting shingles.

Shingles is a rash that is usually on one side of the body. The rash begins as a cluster of small red spots that often blister. The rash can be painful. Shingles rashes usually last up to 30 days and, for most people, the pain associated with the rash lessens as it heals.

Who should not get ZOSTAVAX?

You should not get ZOSTAVAX if you:

- are allergic to any of its ingredients.
- are allergic to gelatin or neomycin.
- have a weakened immune system (for example, an immune deficiency, leukemia, lymphoma, or HIV/AIDS).
- take high doses of steroids by injection or by mouth.
- are pregnant or plan to get pregnant.

You should not get ZOSTAVAX to prevent chickenpox.

Children should not get ZOSTAVAX.

How is ZOSTAVAX given?

ZOSTAVAX is given as a single dose by injection under the skin.

What should I tell my health care provider before I get ZOSTAVAX?

You should tell your health care provider if you:

- have or have had any medical problems.
- take any medicines, including nonprescription medicines, and dietary supplements.
- have any allergies, including allergies to neomycin or gelatin.
- had an allergic reaction to another vaccine.
- are pregnant or plan to become pregnant.
- are breast-feeding.

Tell your health care provider if you expect to be in close contact (including household contact) with newborn infants, someone who may be pregnant and has not had chickenpox or been vaccinated against chickenpox, or someone who has problems with their immune system. Your health care provider can tell you what situations you may need to avoid.

What are the possible side effects of ZOSTAVAX?

The most common side effects that people in the clinical studies reported after receiving the vaccine include:

- redness, pain, itching, swelling, warmth, or bruising where the shot was given.
- headache.

The following additional side effects have been reported in general use with ZOSTAVAX:

- allergic reactions, which may be serious and may include difficulty in breathing or swallowing. If you have an allergic reaction, call your doctor right away.
- fever
- hives at the injection site
- joint pain
- muscle pain
- rash
- rash at the injection site
- swollen glands near the injection site (that may last a few days to a few weeks)

Tell your health care provider if you have any new or unusual symptoms after you receive ZOSTAVAX.

What are the ingredients of ZOSTAVAX?

Active Ingredient: a weakened form of the varicella-zoster virus.

Inactive Ingredients: sucrose, hydrolyzed porcine gelatin, sodium chloride, monosodium L-glutamate, sodium phosphate dibasic, potassium phosphate monobasic, potassium chloride.

What else should I know about ZOSTAVAX?

Vaccinees and their health care providers are encouraged to call (800) 986-8999 to report any exposure to ZOSTAVAX during pregnancy.

This leaflet summarizes important information about ZOSTAVAX.

If you would like more information, talk to your health care provider or visit the website at www.ZOSTAVAX.com or call 1-800-622-4477.

Rx only

Issued April 2009

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Animal horns adorn Krampus costumes worn during pre-Christmas revelry in Munich, Germany.

HOLIDAY THREAT

On this vintage card Krampus is St. Nicholas's driver. Switches in the quiver were meant to keep bad kids in line.



Merry Krampus? A wild Christmas character is making a devilish comeback. Krampus gets his name from a word for “claw.” That’s apt for a demon said to grab naughty children and stuff them in his sack. Popular in Alpine villages centuries ago, Krampus scared kids straight—his long red tongue upped the fear factor—and taught them that evil bows before good. He served Santa’s forerunner, kindly St. Nicholas, who had “the power to send Krampus back to hell,” says Austrian ethnologist Ulrike Kammerhofer-Aggermann.

Europe once had a roster of Christmas rascals like Krampus, many with pagan roots. And Yule was a lot like today’s Halloween, partly because farmers had time off from chores and could party with abandon. On December 5, the eve of St. Nick’s feast day, folks would bang on doors for food and drink.

But by the 1800s, church leaders had marginalized Krampus. Now he’s enjoying a mini-revival, mainly for the fun of it. The Austrian state of Salzburg alone has 180 Krampus clubs, more than half set up since 1990, says Josef Moser, Jr., chairman of Austria’s Krampus Museum. Revelers roam streets in Krampus garb, rattle bells, and roar. “It feels good!” says Moser. Alas, some drink, brawl, even riot—frightening kids and adults alike. —Marc Silver

**Is it a coincidence that blackout
dates fall during school vacations?**



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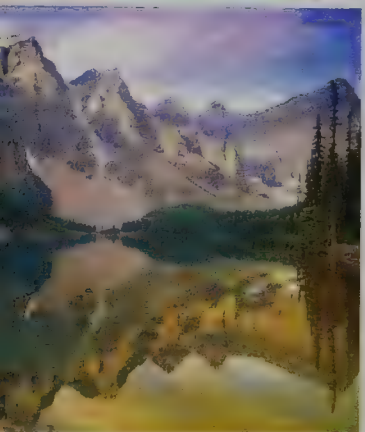


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Everglades National Park and Biscayne Bay ★ First, go deep into the Everglades on an airboat and see exotic wildlife up close. Next, drive through beautiful Miami on your way to Bayside Marina. Board the Biscayne Bay boat for a professional tour past Miami's spectacular coastal sites.

Mountain Lakes and Waterfalls Trip from Banff ★ Take this seasonal tour through the Canadian Rockies and marvel at the beauty of Banff's surrounds. Victoria Glacier, Lake Louise, Ten Peaks, and other incredible scenery await you on this full-day guided coach tour.



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The Fantasia Snorkel Sea Safari is a world of fun for the whole family! Snorkel, slide, and rock climb all on this amazing 72-foot double deck catamaran, the only one of its kind in the Caribbean.

Miami Sunset Air Tour ★ See the sun descend amidst dazzling colors while on this magnificent air tour over Miami. Be sure to bring your camera and capture the sky's transition from late afternoon gold and amber to the brilliant red hues of sunset.

New Orleans Steamboat Natchez Evening Jazz Cruise ★

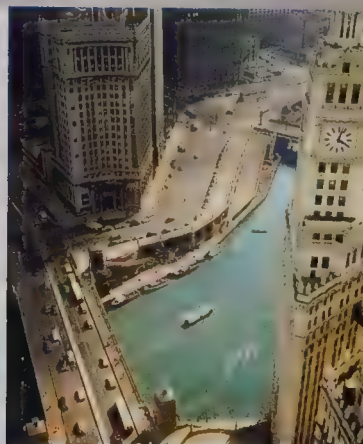
Jazz is the heartbeat of New Orleans and there's no better way to feel the city's pulse than by taking this evening cruise. Board the Steamboat Natchez and hear the Grammy nominated 'Dukes of Dixieland' for a truly memorable experience.

Nashville's Grand Legends Tour ★

Get your country music fix with this tour through Nashville's music scene. See the Grand Ole Opry and Opryland Hotel as well as the Willie Nelson Museum. Finish your day with a stroll along the Country Music Sidewalk of Fame.

Chicago River and Lake Architecture Tour ★

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CHASE 

Sign Language The perfect sign would have no words and be easy to grasp. “The rational thing is to create standard symbols everybody understands,” says David Gibson, author of *The Wayfinding Handbook*. He’s one of many designers the world over who work toward uniformity and understandability.

Yet the unconventional sign has undeniable allure. Doug Lansky curated “Signspotting,” an exhibit that drew crowds in Stockholm and Edinburgh and is traveling to other cities. In his show and in public places, signs can entertain with overkill (No. 16, below) and fanciful images (No. 7). They also let travelers see the world through another culture’s eyes. No. 20 instructs squat-toilet users in Western bathroom etiquette. Says Lansky: “Now I understand why I see footprints on the toilet in an international airport.” —Marc Silver



SIGNPOSTS Traffic-sign expert Susan Chrysler cites studies showing that 40 to 90 percent of onlookers can't decode certain images. Here's a guide to our gallery.

- 1 **South Africa** Very steep ramp leads to crocodile pit
- 2 **United States** No swearing
- 3 **Argentina** Hands off the butterflies
- 4 **South Africa** Brake for dung beetles
- 5 **Germany** No public peeing
- 6 **France** No unleashed dogs
- 7 **Ireland** Sudden drop-off
- 8 **Australia** Speeding endangers cassowaries
- 9 **United States** Beware RV mirrors
- 10 **France** A ski lift how-to
- 11 **Canada** Don't eat shellfish
- 12 **Jamaica** Britishism for speed bump
- 13 **Canada** Logs in water may shift in storm
- 14 **Brazil** Some seats on bus reserved for obese riders
- 15 **Austria** No sledding (the red circle can mean "don't")
- 16 **Switzerland** Skiers beware
- 17 **South Africa** Unauthorized vendors can't sell food
- 18 **Canada** Avalanche danger
- 19 **U.K.** Old folks crossing
- 20 **Cambodia** Toilet etiquette

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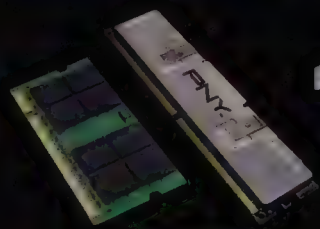
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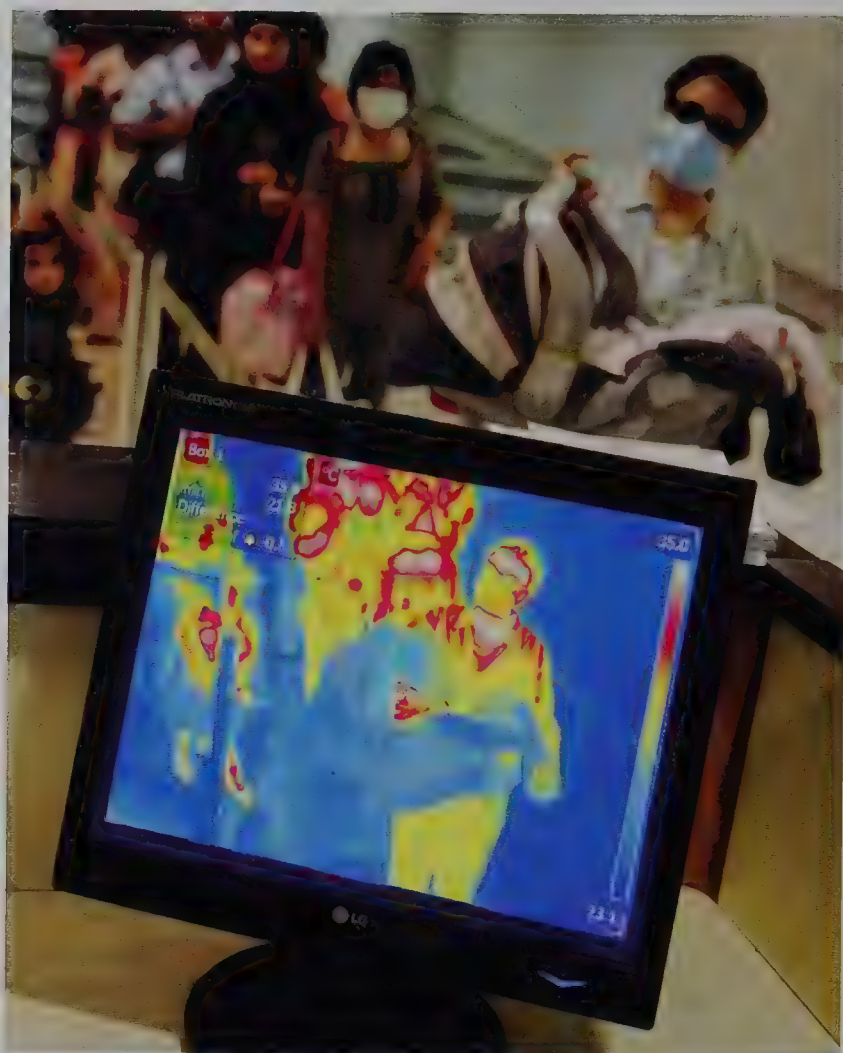
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Passengers are screened at a Beirut airport during the swine flu outbreak.

Fighting the Flu Last summer, public health experts warned that 2009 H1N1, aka swine flu, could afflict up to 50 percent of the U.S. population this flu season. To prepare, officials readied 50 million doses of initial vaccines for children, pregnant women, and health care workers. Though not likely, two other, older techniques— isolation and quarantine—could also eventually be considered.

Isolation separates sick people from well ones. Quarantine limits the movements of those who aren't ill but have been exposed. In lieu of a vaccine, these intrusive, oft-debated measures can curb disease spread, lower death rates, and lessen the toll on hospitals.

Both are "social distancing" tactics. School closures are another. For all, coordination and timing are key. Act too soon, and the costs can outweigh the health benefits; one study says 26 weeks of shuttered U.S. schools could mean lost wages equal to 6 percent of the GDP. Act too late, and more people can die as the virus's attack rate grows. Yet well-timed action can help. In the 1918 flu pandemic, the cities that fared the best—San Francisco, St. Louis, Kansas City, Milwaukee—acted fast and on many fronts. —Melody Kramer

A BRIEF GLOBAL HISTORY OF PUBLIC-HEALTH CONFINEMENTS

CIRCA 600-400 B.C. The Torah offers instructions on isolating lepers and disinfecting the home.

A.D. 549 The emperor Justinian isolates travelers from disease-affected regions during a plague.

1374 In an era of plague, ships must lie at anchor for 40 days ("quaranta" in Italian, ergo "quarantine") prior to docking in Venice.

1892 After typhus fever strikes, Eastern European Jewish immigrants are sent to the same New York island that will later confine Typhoid Mary.

1893 The U.S. National Quarantine Act allows the federal government to enforce containments.

1900 San Francisco's quarantine of Chinatown is ruled discriminatory.

1963 A smallpox carrier is quarantined, the last U.S. confinement until a TB patient is isolated in 2007.

2003 SARS joins plague, smallpox, yellow fever, and tuberculosis on the U.S. quarantine list.

2009 Lacking an H1N1 vaccine, nations kill pigs, prohibit gatherings, and ban flights from Mexico.

Truly
Unique



Rock Around the Clock Tonight

Standing in front of the guitar shop window was the greatest thrill and the worst kind of torture. As a kid, I never had the money to shell out for a mint condition Gibson, Rickenbacker or Les Paul. But they were right there in front of me, lined up like lacquered, mahogany and maple trophies. I could stare for hours at the smooth curves, long necks and the occasional flourish of mother-of-pearl. But I was stuck admiring them from outside, through glass like some kind of museum display.

After playing for what seemed like an eternity on dinged-up secondhanders, I finally got my first Fender Stratocaster. It was worth the wait. I slid it over my shoulder, plugged in and cranked out my best version of "Pipeline." The guitar looked and felt like a masterpiece. That's the thing about a classic guitar, the work of art is the piece you lay...and the piece itself.

It's no wonder then that this remarkable Stauer Guitar Watch instantly hooked at my heartstrings. One look at its voluptuous body brought me right back to the glory days of rock-and-roll.

The unique shape immediately brings to mind those round-bottomed bodies of vintage electric guitars. The same classics strummed by Bill Haley, Buddy Holly and true guitar gods like Jimi, Eric and Keith.

The eye-catching, ivory face features blue Roman numerals on the left of the dial and bold Arabic numbers on the right. Blued, Breguet-style hands keep time while additional complications mark the day, date and month. A date window sits at the 3 o'clock position. Inside, the 27-sapphire-jewel movement utilizes an automatic self-winding mechanism that never needs batteries. The Stauer Guitar Watch secures with a genuine black leather band and is water-resistant to 3 ATMs.

A quick word of caution—I've been wearing the guitar watch for weeks and it has significant side effects. "Chuck Berry's Greatest Hits" has been stuck in my car stereo. I find myself humming Bo Diddley during conference calls and once in a while I take a slow ride past the guitar shop on my way home.

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performance and stage presence of the Stauer 6-String within 30 days, simply return the watch for a full refund of the purchase price. The unique design of the 6-String limits our production to only 4,995 pieces, so don't hesitate to order! Sorry, no Wah Wah pedal included!

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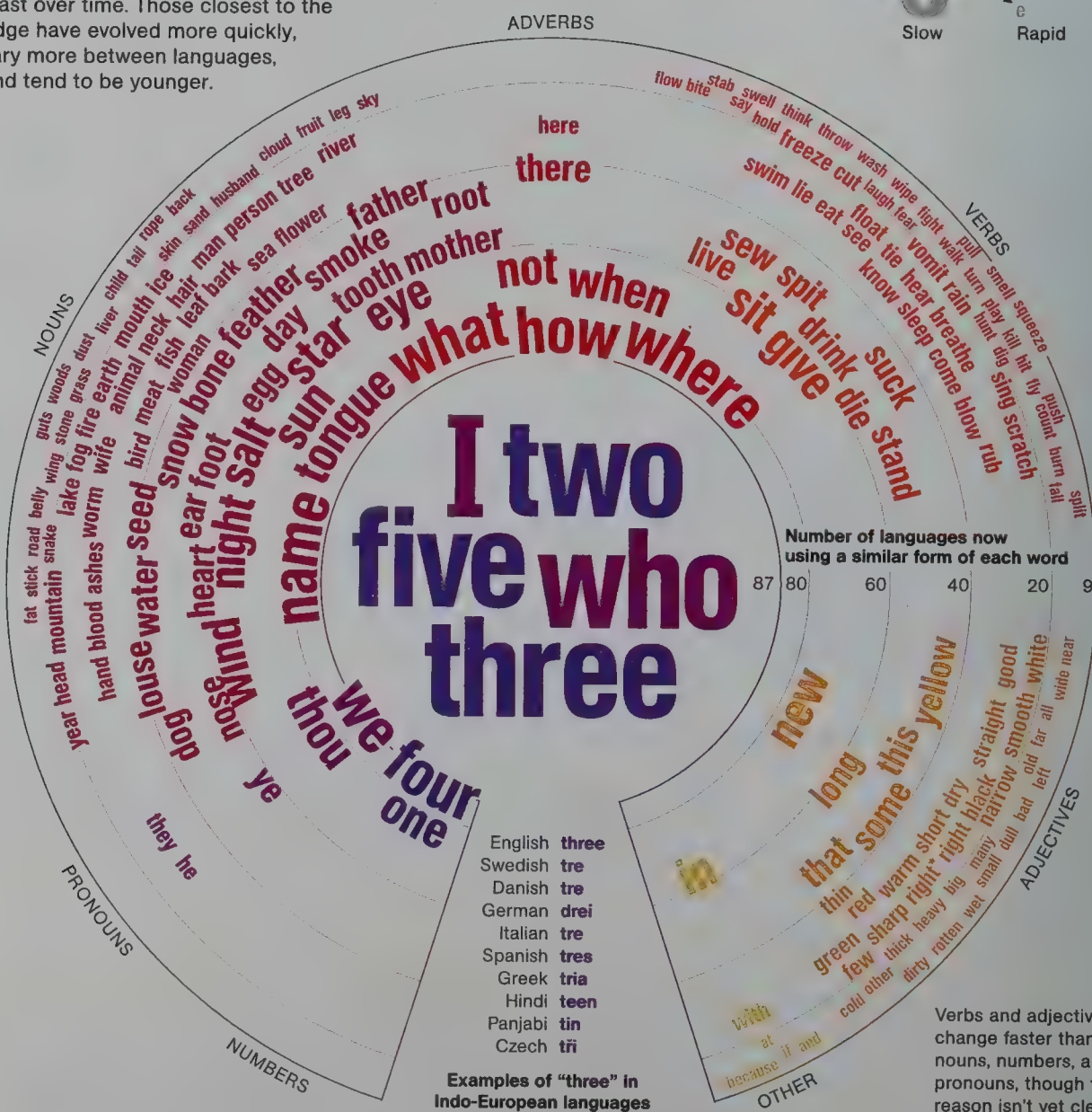
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AS THE WORD TURNS The five words in the center are the oldest of the 200 below and have changed least over time. Those closest to the edge have evolved more quickly, vary more between languages, and tend to be younger.

Rate of Evolution

 Slow Rapid



New Word Order The graphic on this page isn't "refrigerator poetry." It's a landmark study of 87 related languages found in Europe, the Middle East, and the Indian subcontinent. Linguists knew these 200 words (English versions above) shared a 9,000-year-old Mesopotamian ancestry, yet until now couldn't predict which ones would change over time, which ones wouldn't, and why.

But when University of Reading evolutionary biologist Mark Pagel fed the list into a computer, he found the secret of verbal life: Use it or lose it.

Words employed most often in daily speech, such as "I," are the oldest and most stable; their forms or sounds may date back over 10,000 years. Words used the least may be replaced within 800 years. And parts of speech change at different rates.

So will local lingo be homogenized in this age of global media? Not necessarily, says Pagel, citing stiff British resistance to "couch" for "sofa." And though words may be mutable, concepts are not. An old-fashioned value judgment like "bad" will simply find new expression. —Jeremy Berlin

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 OTAKTOICOTCIC
 TOPHAIOTIAAAK
 NOIOMMAOTITAM
 TOYANTHON
 CHCAONOTONOT
 TONHAIOTHON

This image shows a blank, aged, cream-colored page, likely an endpaper or flyleaf of a book. The paper has a slightly textured appearance with some minor discoloration and a dark, vertical stain running down the right edge. The binding edge on the left is visible, showing the inner hinge and some text from the reverse side, which is partially obscured by the binding. The overall tone is warm and aged.

This image shows a blank, aged, cream-colored page, likely an endpaper or flyleaf of a book. The paper has a slightly textured appearance with some minor discoloration and a dark, vertical stain running down the right side, possibly from a binding or a liquid spill. There is no text or other markings on the page.

The virtual archive reunites what remains at the monastery with parts in England, Germany, and Russia. Each page appears in high definition along with a catalog of details. This lets scholars easily study features such as additions and corrections made until the 12th century, when the text was deemed outdated. Says the British Library's Juan Garcés, who's leading the four-year digitization effort, "It was alive for a long time." And now it lives again. —A. R. Williams



A scar from an animal's hide (above) marks one of the 694 bound pages of parchment (top) housed at the British Library in London.

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WHAT IS VYTORIN?

VYTORIN is a medicine used to lower levels of total cholesterol, LDL (bad) cholesterol, and fatty substances called triglycerides in the blood. In addition, VYTORIN raises levels of HDL (good) cholesterol. VYTORIN is for patients who cannot control their cholesterol levels by diet and exercise alone. You should stay on a cholesterol-lowering diet while taking this medicine.

VYTORIN works to reduce your cholesterol in two ways. It reduces the cholesterol absorbed in your digestive tract, as well as the cholesterol your body makes by itself. VYTORIN does not help you lose weight. VYTORIN has not been shown to reduce heart attacks or strokes more than simvastatin alone.

WHO SHOULD NOT TAKE VYTORIN?

Do not take VYTORIN:

- If you are allergic to ezetimibe or simvastatin, the active ingredients in VYTORIN, or to the inactive ingredients. For a list of inactive ingredients, see the "Inactive ingredients" section at the end of this information sheet.
- If you have active liver disease or repeated blood tests indicating possible liver problems.
- If you are pregnant, or think you may be pregnant, or planning to become pregnant or breast-feeding.
- If you are a woman of childbearing age, you should use an effective method of birth control to prevent pregnancy while using VYTORIN.

VYTORIN has not been studied in children under 10 years of age.

WHAT SHOULD I TELL MY DOCTOR BEFORE AND WHILE TAKING VYTORIN?

Tell your doctor right away if you experience unexplained muscle pain, tenderness, or weakness. This is because on rare occasions, muscle problems can be serious, including muscle breakdown resulting in kidney damage.

The risk of muscle breakdown is greater at higher doses of VYTORIN.

The risk of muscle breakdown is greater in patients with kidney problems.

Taking VYTORIN with certain substances can increase the risk of muscle problems. It is particularly important to tell your doctor if you are taking any of the following:

- cyclosporine
- danazol
- antifungal agents (such as itraconazole or ketoconazole)
- fibric acid derivatives (such as gemfibrozil, bezafibrate, or fenofibrate)
- the antibiotics erythromycin, clarithromycin, and telithromycin
- HIV protease inhibitors (such as indinavir, nelfinavir, ritonavir, and saquinavir)
- the antidepressant nefazodone
- amiodarone (a drug used to treat an irregular heartbeat)
- verapamil (a drug used to treat high blood pressure, chest pain associated with heart disease, or other heart conditions)
- large doses (≥ 1 g/day) of niacin or nicotinic acid
- large quantities of grapefruit juice (>1 quart daily)

It is also important to tell your doctor if you are taking coumarin anticoagulants (drugs that prevent blood clots, such as warfarin).

Tell your doctor about any prescription and nonprescription medicines you are taking or plan to take, including natural or herbal remedies.

Tell your doctor about all your medical conditions including allergies.

Tell your doctor if you:

- drink substantial quantities of alcohol or ever had liver problems. VYTORIN® (ezetimibe/simvastatin) may not be right for you.
- are pregnant or plan to become pregnant. Do not use VYTORIN if you are pregnant, trying to become pregnant or suspect that you are pregnant. If you become pregnant while taking VYTORIN, stop taking it and contact your doctor immediately.
- are breast-feeding. Do not use VYTORIN if you are breast-feeding.

Tell other doctors prescribing a new medication that you are taking VYTORIN.

HOW SHOULD I TAKE VYTORIN?

- Take VYTORIN once a day, in the evening, with or without food.
- Try to take VYTORIN as prescribed. If you miss a dose, do not take an extra dose. Just resume your usual schedule.
- Continue to follow a cholesterol-lowering diet while taking VYTORIN. Ask your doctor if you need diet information.
- Keep taking VYTORIN unless your doctor tells you to stop. If you stop taking VYTORIN, your cholesterol may rise again.

WHAT SHOULD I DO IN CASE OF AN OVERDOSE?

Contact your doctor immediately.

WHAT ARE THE POSSIBLE SIDE EFFECTS OF VYTORIN?

See your doctor regularly to check your cholesterol level and to check for side effects. Your doctor may do blood tests to check your liver before you start taking VYTORIN and during treatment.

In clinical studies patients reported the following common side effects while taking VYTORIN: headache, muscle pain, and diarrhea (see What should I tell my doctor before and while taking VYTORIN?).

The following side effects have been reported in general use with VYTORIN or with ezetimibe or simvastatin tablets (tablets that contain the active ingredients of VYTORIN):

- allergic reactions including swelling of the face, lips, tongue, and/or throat that may cause difficulty in breathing or swallowing (which may require treatment right away), rash, hives; raised red rash, sometimes with target-shaped lesions; joint pain; muscle pain; alterations in some laboratory blood tests; liver problems (sometimes serious); inflammation of the pancreas; nausea; dizziness; tingling sensation; depression; gallstones; inflammation of the gallbladder; trouble sleeping; poor memory.

Tell your doctor if you are having these or any other medical problems while on VYTORIN. This is not a complete list of side effects. For a complete list, ask your doctor or pharmacist.

GENERAL INFORMATION ABOUT VYTORIN

Medicines are sometimes prescribed for conditions that are not mentioned in patient information leaflets. Do not use VYTORIN for a condition for which it was not prescribed. Do not give VYTORIN to other people, even if they have the same condition you have. It may harm them.

This summarizes the most important information about VYTORIN. If you would like more information, talk with your doctor. You can ask your pharmacist or doctor for information about VYTORIN that is written for health professionals. For additional information, visit the following web site: vytorin.com.

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Butylated hydroxyanisole NF, citric acid monohydrate USP, croscarmellose sodium NF, hypromellose USP, lactose monohydrate NF, magnesium stearate NF, microcrystalline cellulose NF, and propyl gallate NF.

Issued May 2009



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Why would we do this? Our real goal is to build a long term client relationship with you. We are sure that most of you will become loyal Stauer clients in the years to come, but for now, in this lousy economy, we will give you these pearls to help with your future gift giving ideas.

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order at the last minute so we grabbed all of them. He sold us an enormous cache of his roundest, whitest, most iridescent cultured 5 1/2-6mm pearls for only pennies on the dollar.

But let me get to the point: his loss is your gain. Many of you may be wondering about your next gift for someone special. In the past, Stauer has made gift giving easier with the absolute lowest prices on fine jewelry and luxury goods. This year, we've really come to the rescue.

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The Carbon Bathtub

It's simple, really: As long as we pour CO₂ into the atmosphere faster than nature drains it out, the planet warms. And that extra carbon takes a long time to drain out of the tub.

What if we stop increasing emissions?

Even at the current emissions rate, CO₂ is released into the atmosphere nearly twice as fast as it is removed—so the bathtub will continue to fill.

How do we cause CO₂ emissions?

Four-fifths is from burning fossil fuels. Nearly all the rest is from deforestation and other changes in land use.

Where does our CO₂ go?

Plants and soil absorb about a third each year, and ocean surface waters about a quarter. The rest stays airborne for a long time.

How much is too much?

No one is sure. Some scientists think we need to reduce the CO₂ level back down to 350 parts per million (ppm)—equivalent to 745 billion metric tons of carbon—to avoid serious climate impacts. But if current emissions trends continue, 450 ppm will be passed well before mid-century.

45% REMAINS IN ATMOSPHERE

30% ABSORBED BY PLANTS & SOILS

25% ABSORBED BY OCEANS

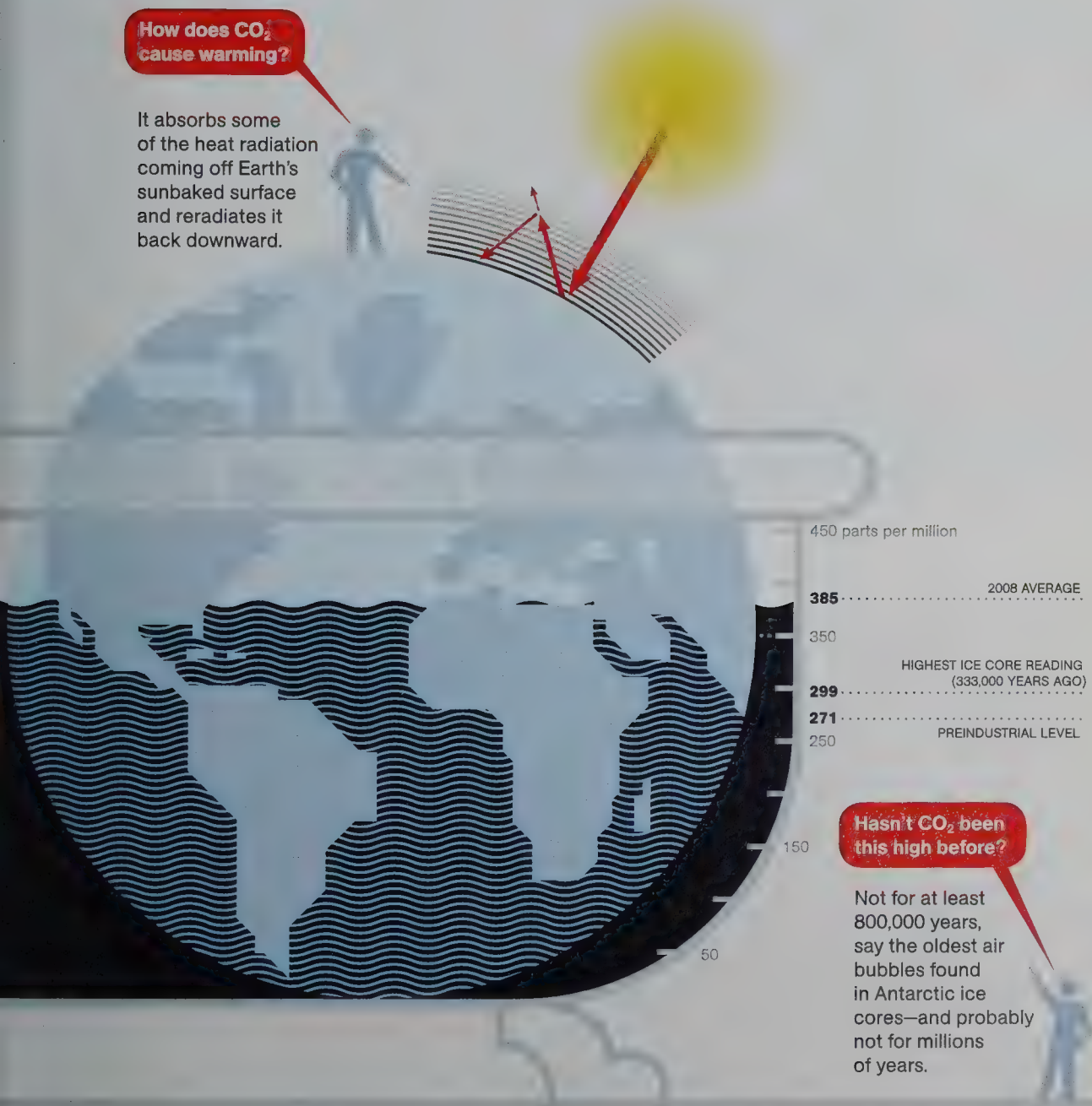
<1% ABSORBED BY SEDIMENTS & ROCKS*



A fundamental human flaw, says John Sterman, impedes action on global warming. Sterman is not talking about greed, selfishness, or some other vice. He's talking about a cognitive limitation, "an important and pervasive problem in human reasoning" that he has documented by testing graduate students at the MIT Sloan School of Management. Sterman teaches system dynamics, and he says his students, though very

bright and schooled in calculus, lack an intuitive grasp of a simple, crucial system: a bathtub.

In particular, a tub with the tap running and the drain open. The water level can stand for many quantities in the modern world. The level of carbon dioxide in Earth's atmosphere is one. A person's waistline or credit card debt—both of which have also become spreading problems of late—are two more. In all *(Continued on next page)*



*PERCENTAGES DO NOT ADD UP TO 100 BECAUSE OF ROUNDING.
GRAPHIC: NIGEL HOLMES. SOURCES: JOHN STERMAN, MIT; DAVID ARCHER, UNIVERSITY OF CHICAGO; GLOBAL CARBON PROJECT

As seen on National Geographic Channel's
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What if we stop emissions completely?

It will take centuries for plants and the ocean to soak up most of the human-made CO₂. It will take hundreds of millennia for the rest to be removed by rock weathering, which converts CO₂ to carbonate sediments and rocks.



Why would the level stay high for so long?

Plants and soil absorb CO₂ quickly, but that reservoir fills up fast.

The deep ocean is bigger, but access is slow; CO₂-laden surface water sinks at only two places near the Poles.

Carbonate sediments and rocks are far bigger and slower still; they form at sea from elements weathered off rocks on land.

PLANTS & SOIL

DEEP OCEAN

SEDIMENTS & ROCKS

three cases, the level in the tub falls only when the drain runs faster than the tap—when you burn more calories than you eat, for instance, or pay off old charges faster than you incur new ones.

Plants, oceans, and rocks all drain carbon from the atmosphere, but as climatologist David Archer explains in his book *The Long Thaw*, those drains are slow. It's going to take them hundreds of years to remove most of the CO₂ that humans are pouring into the tub and hundreds of thousands of years to remove it all. Stopping the rise of CO₂ will thus require huge cuts in emissions from cars, power plants, and factories, until inflow no longer exceeds outflow.

Most of Sterman's students—and his results have been replicated at other universities—didn't understand that, at least not when the problem was described in the usual climate jargon. Most thought that simply stopping emissions from rising would stop the rise of CO₂ in the atmosphere—as if a tap running steadily but rapidly would not eventually overflow the tub. If MIT

graduate students don't get it, most politicians and voters probably don't either. "And that means they think it's easier to stabilize greenhouse gases and stop warming than it is," Sterman says.

By 2008, the level of CO₂ in the tub was 385 parts per million (ppm) and rising by 2 or 3 ppm each year. To stop it at 450 ppm, Sterman says, a level many scientists consider dangerously high, the world would have to cut emissions by around 80 percent by 2050. When diplomats convene in Copenhagen this month to negotiate a global climate treaty, Sterman will be there to help, with software that shows immediately, based on the latest climate-model forecasts, how a proposed emissions cut will affect the level in the tub—and thus the temperature of the planet. His students are generally much better at bathtub dynamics by the end of his course, which gives him hope. "People can learn this," he says. —Robert Kunzig



Tub Dynamics To experiment with the effects of different emissions cuts, go to ngm.com/bigidea.





The Uygurs, Muslim people of China's resource-rich far west, are becoming strangers in their own land as Han Chinese pour in. Like the Tibetans, who face similar pressures, some Uygurs see a chance for a better life, but others protest the disintegration of their culture, even at the risk of death.

THE OTHER TIBET

BY MATTHEW TEAGUE PHOTOGRAPHS BY CAROLYN DRAKE



DIVIDED CITY: A window frame splits the view of Urumqi's Noghay Mosque from Chinese-style development. In July, riots erupted here in Xinjiang's capital, pitting Uygurs against Han Chinese.





ALONE IN A CROWD, a Uyghur woman (at right) shops at a Chinese market in Karamay, an oil-industry city dominated by Han. Although they make up nearly half of Xinjiang's population, Uyghurs hold few top jobs.

办物口

源于京城 风靡

办物口
1993 12:30





JULY 13, 2009

THE FIRST SEVERAL SECONDS of the incident in Urumqi seemed almost lighthearted, considering the previous week. And they revealed nothing about what would follow. A cool front had swept over the city on this particular day in July, drawing people from their homes. Some shops stayed closed because their windows had been shattered, but food vendors pushed their carts out onto the street. A week earlier an ethnic clash had broken out here, killing almost 200 people in one of China's most deadly protests since the Tiananmen Square massacre two decades ago. So the Chinese government had sent tens of thousands of security forces into

*Documented on a bystander's cell phone,
a Uygur man lies in a street in Urumqi,
shot by security forces after charging
them with what appeared to be a sword.*

the city, the capital of the Xinjiang Uygur Autonomous Region, to restore order between the Han and the Uygurs. The Han dominate Chinese society, but the Uygurs (pronounced wee-gurs), a Turkic-speaking Central Asian people, claim this western borderland as their ancestral home.

Han security forces stood in ranks along every street in the city's Uygur quarter. They bristled with riot gear and automatic weapons. The only sound came from loudspeakers mounted on trucks that trawled the market streets, broadcasting the good news of ethnic harmony. If Urumqi had an edge of unrest on this Monday, it was sheathed in silence.

Most Uygurs are Muslims, and about noon I stood on the street in front of a central mosque wondering how many people might be inside. As if in answer, a mass of humanity came pouring out, hundreds of people tumbling and plunging into the street.

Bystanders watched, puzzled, but the emerging crowd offered only odd and inscrutable clues: Many hadn't had time to pull on their shoes and ran in just their socks. They cried out with alarm or possibly in celebration, and their faces glowed with either fear or joy. If they were fleeing from danger, there was no sign of it, and the group split and flew north and south. In the flicker of a moment they had disappeared.

Now three men stepped from the mosque, holding what looked like wooden sticks. One wore a blue shirt, one a black shirt, and one a white shirt. They shouted and smiled, which gave their faces a buoyant quality. Their tiny rally seemed brash: Did they not see the Chinese police on every corner or hear the amplified news about manifest happiness?

They turned southward. All three walked with peculiar long strides and waved their sticks overhead, like three baton-twirling drum majors whose marching band had run ahead of them. They passed rows of market stalls where people shouted to them to stop whatever they were doing. Shop owners slammed shut their stall doors. After two blocks the men stopped and turned back north; just before they reached

me, they crossed the street. They still held up what were, more likely, rusted swords.

Once across the street, they burst into a run, heading toward a group of armed Chinese. The man in blue sprinted ahead; he seemed to catch the government forces off guard, because they turned and ran. The details of the next moment—the angle of the running man, his shirt billowing behind him, the strange coolness of the air—were etched by a sound: a gunshot. But the three Uygurs did not stop in the face of destruction. They tilted toward it.

THE TIBETAN STRUGGLE for independence from China has long captivated the West. Fewer people are familiar with an arguably more critical struggle in a neighboring hinterland: that of the Uygurs. Their anonymity is ironic because the West has played an unwitting role in their current crisis—and because the Uygurs, whose culture is fading toward obscurity, once occupied the center of the known world.

Xinjiang sits in the middle of Asia, encircled by some of Earth's highest mountains, as though a drawstring had cinched the top of the world like a coin purse. Passes through those snowy mountains funneled ancient traders and travelers along paths that became the renowned Silk Road. "They say it is the highest place in the world," Marco Polo wrote of climbing the Pamir mountains from the Afghanistan side. When he emerged from the pass, he found the Uygur homeland and marveled: "From this country, many merchants go forth about the world."

The territory became the fulcrum on which Asia and Europe balanced. Turkic raiders and later Genghis Khan, Buddhists and then Muslims, traders and tribesmen, missionaries and monks—all passed through this hemispheric crossroads, and each group left something of itself. I saw a Uygur woman wearing a Muslim head cover and holding her baby, whose head

Matthew Teague wrote about camels in the August issue. From her base in Istanbul, Carolyn Drake documents the lives of people across Central Asia.



she had shaved into phantasmagoric designs, a pre-Islamic shamanistic practice to frighten away baby-stealing evil spirits. Xinjiang's history is also written in the faces of its people: dark faces with oval eyes. Also fair faces with narrow, jet eyes. And sometimes blue eyes with blond hair.

Geography itself protects the mosaic of Uygur culture in Hotan, in far southwestern Xinjiang. A range of snowcapped mountains rises at the town's back, and before it lies the Taklimakan, a desert larger than Poland, which people sometimes call the Sea of Death. Hotan's inhabitants are mostly farmers, and many of them come together each Sunday outside the town for a bazaar where children eat sweetened ice shaved from chunks that float down the Karakax (Black Jade) River, women browse tents full of silk, and men gather to have their beards trimmed while they tell jokes.

It's an old scene, although there is an occasional sign of technology: Knifemakers sit in long rows on ancient bicycles they've reconfigured to spin grindstones, looking like an invading horde of spark-spitting cyclists. A young Uygur man named Otkur (the names of Uygurs in Xinjiang

have been changed for their protection) shared his bowl of sheep's lung with me, and afterward we approached an astonishing device: a two-story-high swing set with a seat big enough for two people to stand on. Otkur smiled. "For playing," he said. Two women climbed onto the ends of the seat and swung so high they disappeared into tree branches.

In town I met Dawud, a music master who teaches a small group of students. In his school a large mural showed a *mashrap*, a traditional all-male gathering—now closely regulated by the Chinese—where Uygurs convene to play music, recite poetry, and socialize. Dawud fashioned a fingerpick from a piece of wire and some twine, flicked his fingers across the five strings of a tambur, and launched into a series of complex songs with roots that reach back at least five centuries.

Those patchwork elements of Uygur life underscore something crucial about the Uygurs as a whole: Centuries of living at a great Eurasian way station have made them a complicated people who defy careless classification. But in time the world forgot this, with disastrous results.

RAISING HER VOICE, *a Han teacher calls out the correct answer in Chinese at a Uygur high school. Despite an official bilingual policy, the Uygur language is disappearing from classrooms. Some Uygur parents want their children to learn Chinese as a way to get ahead, but many decry the stifling of language and identity. Surveillance cameras at a new Uygur housing project in Kashgar (right) reinforce Chinese control.*



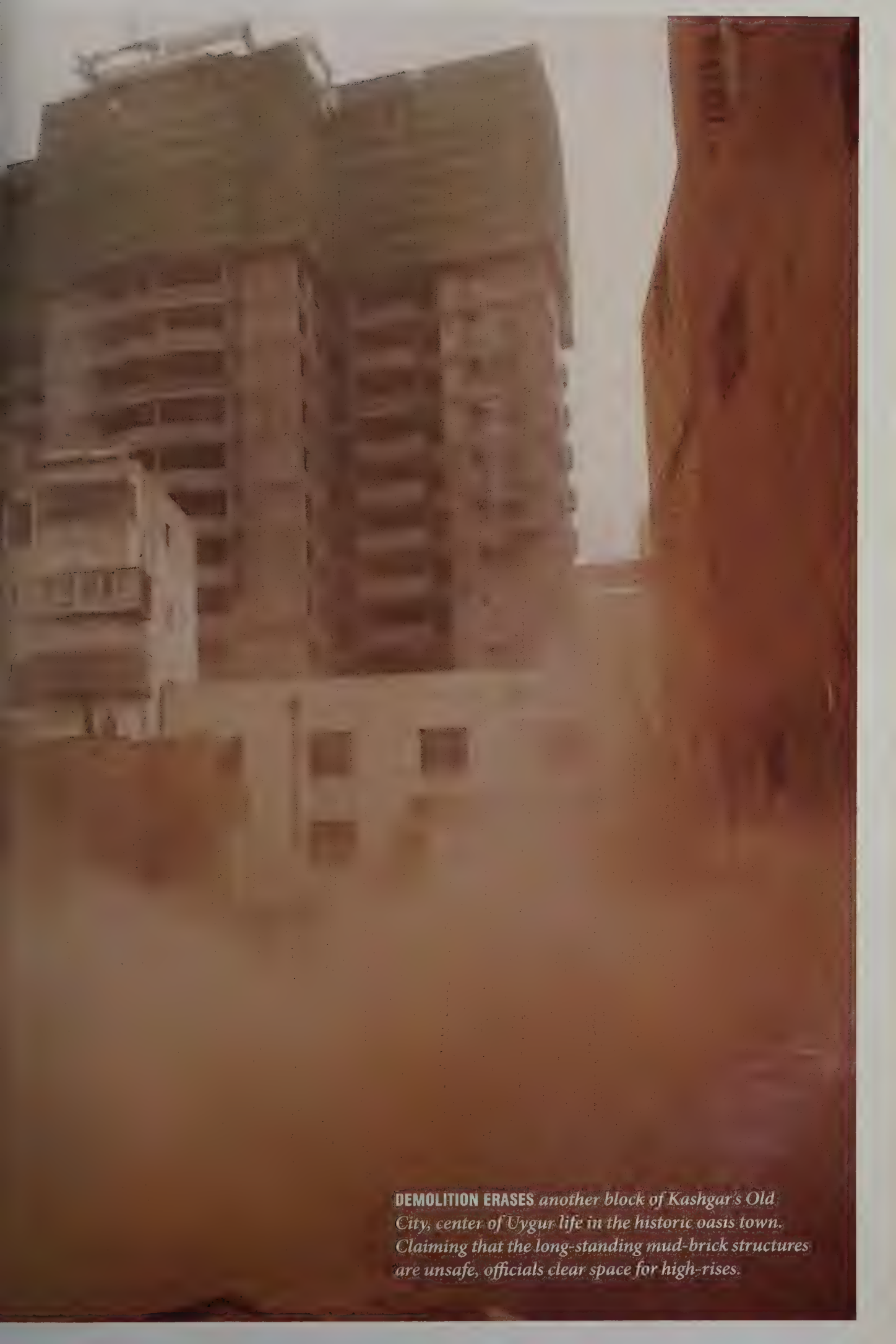
THE CHINESE WERE DISCOVERING THAT XINJIANG OFFERED MORE THAN A BORDER CUSHION: IT HELD SOMETHING VITAL TO THEIR SURVIVAL.

AS THE SILK ROAD began to fray and trade took to the seas, both East and West lost interest in the Uygurs and their mountain fastness. For generations China saw little promise in this remote land—Xinjiang means “new frontier”—because the Chinese prized agriculture, and the wild west offered only dust and stones. People there ate mutton, not pork. In 1932 a British officer traveling in Xinjiang wrote with dark foresight, “Perhaps an awakening China, wondering where to settle its surplus millions of people, may have the good sense to call in the science of the West and to develop [Xinjiang].” But through the early 20th century, the Chinese government did not extend its influence to the distant region, and the Uygurs twice declared their own independent country. The second attempt at self-determination, in 1944, lasted five years, until the rise of Mao and the Chinese Communist Party, which sent in military forces and later established a nuclear testing ground, Lop Nur, in Xinjiang to eliminate any confusion.

Realizing that, if nothing else, its big, empty territory provided a buffer against foreign influence, Mao’s China instituted a program called the Xinjiang Production and Construction Corps—combining farm, military garrison, and prison—in which settlers from other Chinese provinces would work the soil and watch the borders. The first arrivals, in 1954, included more than 100,000 demobilized soldiers. Some were coerced, but the flow gathered momentum as the government extended a railroad west to Urumqi in 1962 and used promises of food and clothing to entice residents from overcrowded cities like Shanghai.

Meanwhile the Chinese were discovering that Xinjiang offered far more than just a border cushion: It held something vital to their very survival as a nation. Xinjiang contains about 40 percent of China’s coal reserves and more than a fifth of its natural gas. Most important, it has nearly a fifth of the nation’s proven oil reserves, although Beijing claims it holds as much as a third. Never mind the massive deposits of gold, salt, and other minerals. Xinjiang isn’t empty. It’s strategic. And with that realization, other things came sharply (Continued on page 46)





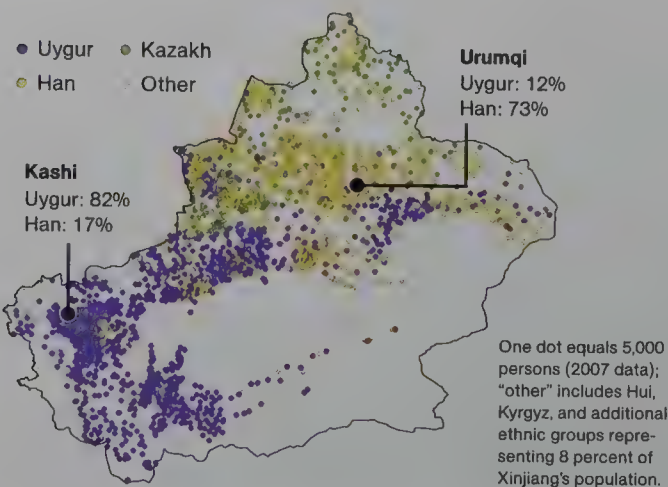
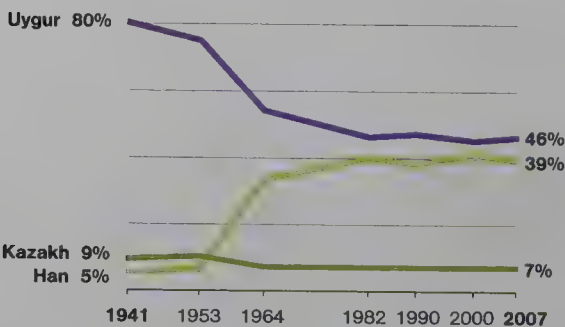
DEMOLITION ERASES *another block of Kashgar's Old City, center of Uygur life in the historic oasis town. Claiming that the long-standing mud-brick structures are unsafe, officials clear space for high-rises.*

EXPLOITING A RICH FRONTIER

Where merchants once trekked through western China on the Silk Road, today pipelines, highways, and railroads serve as conduits of wealth. In recent years Xinjiang ("new frontier") has attracted a flood of Han Chinese, with many going to new town sites like Alar (right) on the desert rim. Uygurs still dominate the rural south, but the north looks increasingly like the rest of booming China.



NEWCOMERS The population of Han Chinese in Xinjiang has swelled by 2.5 million since the 1990s, when Beijing's "Develop the West" initiative began a rush from the interior and the east coast. If the inflow continues, Han could soon outnumber Uygurs in their traditional homeland.



Xinjiang is China's leading cotton producer, with 38 percent of the total. Most is grown on irrigated desert near Aksu and Kashgar.



ENERGY IN XINJIANG

COAL

40% of China's proven reserves

Coal-bearing area

GAS

21% of China's proven reserves

Natural gas pipeline

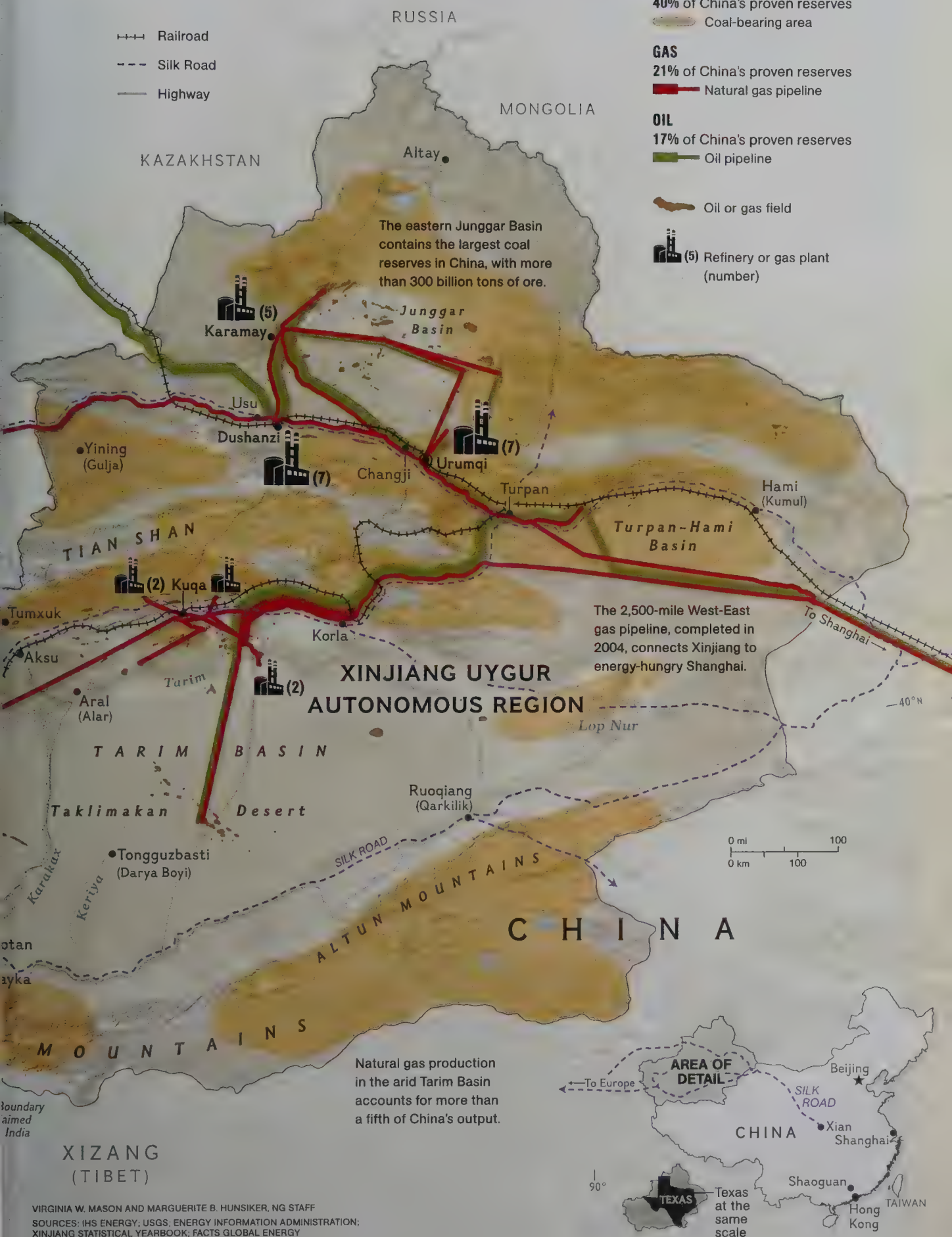
OIL

17% of China's proven reserves

Oil pipeline

Oil or gas field

(5) Refinery or gas plant
(number)





DISTINCTLY UYGUR, the Sunday bazaar in Layka teems with shoppers in colorful scarves and embroidered caps. Here livestock sales, the hawking of crafts, and matchmaking schemes unfold as in generations past.





into focus for China's leadership: Xinjiang is the largest, most far-flung region. It borders more countries than any other. And it's home to an ethnic group that has tried twice in living memory to make a break for freedom.

In 1947, during the second incarnation of Uygur independence, about 220,000 Han Chinese made up 5 percent of Xinjiang's population. Uygurs numbered about three million, or 75 percent, the remainder being a mix of Central Asian ethnicities. By 2007 the Uygur population had increased to 9.6 million. But the Han population had swelled to 8.2 million.

Some Uygurs found opportunity in the influx. In the 1980s in burgeoning Urumqi, a laundress named Rebiya Kadeer grew her business into a department store, then built that into an international trading empire. She became one of the wealthiest people in China and an inspiration for her compatriots—a Uygur woman who appeared in Asia's *Wall Street Journal* and met with such businessmen as Bill Gates and Warren Buffett. In many ways she seemed emblematic of Xinjiang: In the last two decades of the 20th century the region's GDP increased tenfold.

But many more Uygurs languished. The big

business in Xinjiang is oil, but all that oil is controlled from Beijing by state-owned energy companies. Many of the good jobs in Xinjiang are government jobs, and employees can advance more readily if they join the Communist Party, which requires renouncing their religion. And most Uygurs won't do that. The result is an ironic and combustible symmetry: As Han settlers pour in, Uygurs, unable to find work in their fantastically wealthy and spacious homeland, migrate east to work in privately owned factories in crowded coastal cities.

IN THE PAST FEW DECADES local resistance has flared up around Xinjiang, fluctuating in scale and violence. During the 1980s Uygur students protested treatment by police in a handful of incidents; in 1990 a disturbance south of Kashgar against birth limits ended in perhaps four dozen deaths. In 1997 hundreds of people in a city called Gulja marched to protest repression of Islamic practices and were arrested; the number of casualties is unknown. Other examples abound, including bus bombings and assassinations.

The Chinese government realized that it had

DAYBREAK in the village of Darya Boyi finds a daughter doing chores (left). Brightly draped wooden platforms serve as beds, and a future meal of mutton hangs from a hook. Uygur activists complain that government programs pressure young women in villages to move east to work in factories. Following tradition in the city, women in Kashgar (right) take home gifts of flatbread after a wedding.



UYGUR HOMES ARE LIKE OYSTERS: ON THE OUTSIDE DRAB, BUT INSIDE, WALLS GLEAM, AND COLORED RUGS COMPLEMENT PAINTED CEILINGS.

a problem in Xinjiang, much as it had a problem in neighboring Tibet. Along with regulating mashraps—those traditional gatherings—the state monitored services at mosques, afraid they might provide a platform for dissidents. In general, officials downplayed the unrest as the work of isolated “ruffians” in a Uygur population that was otherwise blissful. In early September 2001, Xinjiang Communist Party Secretary Wang Lequan announced in Urumqi that “society is stable, and people are living and working in peace and contentment.”

A few days later Beijing received a potent and unexpected propaganda tool: September 11.

As America and much of the West launched the “war on terror,” China recognized the momentum of global public opinion and chose a new tack. The shift happened so fast it came with an almost audible crack. On October 11 a spokesman for the Chinese Foreign Ministry described China as “a victim of international terrorism.” Then the government issued a report

on unrest in Xinjiang blaming none other than Osama bin Laden. “It’s an effective strategy,” says James Millward, a professor at Georgetown University and an expert on Xinjiang, “because in America we see Muslims somewhere who are unhappy and maybe even violent, and we assume it’s because of religious reasons.”

And just like that, the Uygurs—with the complexity of their culture, the richness of their past, the fullness of their grievance against the Chinese state—fell into a tidy classification. China asked the United States to include a group of militant separatist Uygurs on its list of terrorist organizations but was rebuffed—at least at first.

In December 2001, 22 Uygurs were captured in Pakistan and Afghanistan, where they may have received weapons training with the intent of battling the Chinese military back in Xinjiang. The men were rounded up by bounty hunters, handed over to U.S. forces, and sent to Guantánamo Bay. (Years later a U.S. court would order their release.) In August 2002 Deputy Secretary of State Richard Armitage traveled to Beijing to discuss, among other issues, America’s upcoming mission in Iraq. While there, he announced a reversal in the U.S. stance: A militant Uygur group



NEAR HOTAN, gamblers crowd around after a dog fight—a sharp contrast to the folk dances and wrestling matches Uyghurs perform for tourists. In rural areas especially, men and women tend to socialize separately.



called the Eastern Turkistan Islamic Movement would now be listed as a terrorist organization.

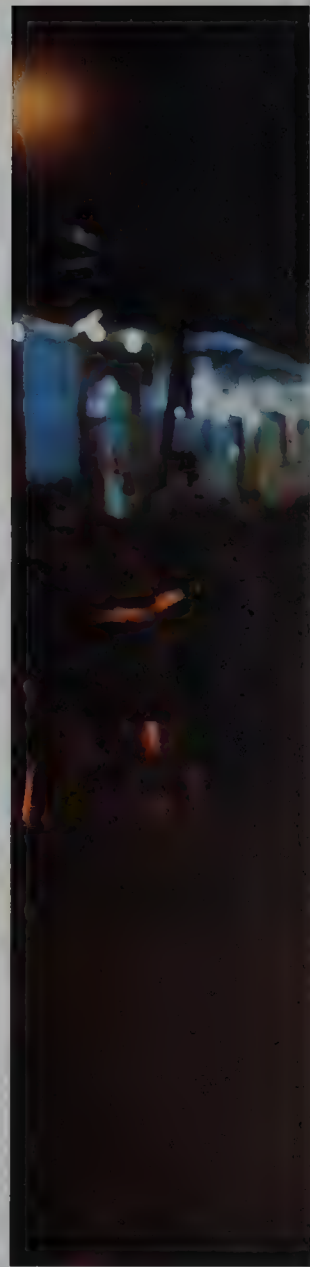
THE HEART OF UYGUR tradition is the ancient capital of Kashgar. Today its Old City looks much as it must have when Marco Polo spied it after descending through the mountain pass—a warren of passageways and ancient mud-brick homes that resemble a jumble of oversize children's blocks. Early this year the Chinese government undertook a bold step: They began systematically bulldozing the Old City block by block and moving the inhabitants into a new compound on the edge of town.

Uygurs don't discuss the subject in public for fear of imprisonment, but one man who lives in the Old City, Ahun, agreed to talk with me in his home. A rendezvous would not be easy, because for days the Chinese security services had been following me. I was to wait in the main square during the busy midday until I saw him pass under Mao's statue, then follow at a distance without acknowledgment.

As we walked through city streets, he stopped casually to take a drink of water at a cart and later to tie his shoe. Finally we entered the Old City. The Chinese government's ostensible reason for demolishing the neighborhood is that it's too old to withstand an earthquake. But there may be another motive. As Ahun and I wove our way deeper into the warren, I watched his shoulders relax and his gait loosen. He was hard to trace in here. The Old City is a refuge.

The homes are adjacent and interconnected, and each is two stories high and arranged around a central courtyard. I followed Ahun up a flight of stairs, and when he flung open the door, it struck me that these homes are like oysters: On the outside they're drab and crude, but on the inside whitewashed plaster walls gleam, and many-colored rugs complement painted ceilings. "I pray. When I worship, I ask Allah, 'Rescue me my house,'" Ahun said. From his house he has a clear view of a government wrecking crew at work on a nearby home. According to the demolition schedule, they'll arrive at Ahun's home in three years.

IDLING at a night market in Kashgar, a motorcycle taxi driver waits for his next fare. Limited job opportunities tend to stall many Uygurs as the gap widens between haves and have-nots. According to a U.S. government report, in a recent recruiting effort the Xinjiang Production and Construction Corps reserved some 800 of its 840 civil service job openings for Han workers.



He was born in the house, he said. So was his father. So was his grandfather, after his great-grandfather built it on family land. "I have two sons," he said. That's five generations who have lived in the same house.

If Hotan represents Xinjiang's past—with a Uygur majority that gathers to sharpen knives, trim beards, sing songs—then Kashgar is its present. Uygurs still make up most of the city's population, but their culture here is embattled. The government is working fast to tear it down.

Given enough time, Ahun said, China's economic development will bring political change, and hope for his people. "China will be obliged to receive a democratic system," he said. But right now, for a man who prays each day for the survival of his family home, no act is too desperate. "You do not understand our rage,"



he said. “In the Middle East there are human bombs, who connect their bodies with bombs. But with our rage, we don’t need bombs connected. We ourselves explode.”

IN JUNE OF THIS YEAR, a disgruntled worker at a toy factory in Shaoguan, near Hong Kong, reportedly claimed that Uygurs had raped two women. A melee followed. The violence lasted several hours and left scores injured. Angry Han workers in the factory’s dormitory beat to death two Uygur co-workers.

This spark lit a fire 2,000 miles away, in Xinjiang. On July 5 thousands of Uygurs—the numbers reported varied widely—took to Urumqi’s streets to protest the treatment of the Uygur workers. The authorities were caught off guard.

I spoke to a young woman named Arzigul,

who had attended the protest. She said it started off peacefully as young people circulated around the capital’s public square. “They were screaming the name ‘Uygur! Uygur! Uygur!’” she said. When security forces arrived, something happened—exactly what is unclear. Each side says the other struck first, but at some point the authorities tried to quell the crowd, which apparently devolved into a mob attacking Han on the street. Two days later a group of Han—apparently numbering in the thousands—took to the street with meat cleavers and clubs and knives. They in turn attacked Uygurs.

Chinese officials say they’re protecting their citizens from terrorists. In July, Vice Foreign Minister He Yafei called the riots “a grave and violent criminal incident plotted and organized by the outside forces of terrorism, separatism,

A photograph capturing a scene of religious devotion amidst a harsh natural environment. In the foreground, a man stands with his hands clasped in prayer, wearing a dark robe and a white head covering. He is positioned on a sandy, uneven ground. Behind him, a large group of people, also in traditional attire, are gathered, some standing and some kneeling, all seemingly engaged in prayer. The background is dominated by a thick, yellowish-brown haze of sand and dust, which obscures the landscape and the sky. In the distance, faint silhouettes of hills or mountains are visible through the haze. The overall atmosphere is one of solemnity and resilience in the face of adversity.

UNBOWED BY A SANDSTORM, pilgrims pray at the graves of Islamic saints during the Imam Asim festival near Hotan. Chinese officials restrict activities at mosques but so far have tolerated rural religious gatherings.



and extremism.” James Millward, the Xinjiang expert, says many Han—even officials—sincerely believe Xinjiang faces a threat from terrorists and interlopers. “It’s what they are constantly told.” Eventually military forces and police clamped down on Urumqi, and there seemed no possibility of further unrest. That’s when the three men emerged from the mosque in the Uygur quarter, scattering people in every direction.

I WATCHED THEM stride up the street and back, then run at the Chinese forces. First came the single shot, which missed. The Uygurs continued their charge, and I realized that the running men with their rusted swords did not expect to prevail. They expected to die.

A moment later another officer released a burst of automatic fire. The lead Uygur—the man in the flowing blue shirt—fell with the sudden slackness of a thrown rag doll. His body hit the pavement, but the momentum of his sprint sent him tumbling, and his feet flew up and over his head.

For a few seconds the incident played out in tableau on the opposite sidewalk. The remaining two Uygurs ran into the street, and the scene became three-dimensional, with bullets flying in my direction. I ran into a nearby building and found myself in the lobby of an enormous department store. People pressed themselves into corners and behind clothing displays; women wailed, and two men improvised a door lock by shoving a metal bar through the door’s handles. Beyond the building’s glass doors, all three of the Uygur men now lay in the street, one injured and two dead. Soldiers, police, and plainclothes security officers were firing upward, into the windows of surrounding buildings.

The department store held special significance for the Uygurs. It belonged to their heroine Rebiya Kadeer, the laundress turned mogul who had become beloved after she began to speak out against China’s treatment of the Uygurs. In 1999, as an American delegation arrived in China to meet Kadeer, security officers arrested her. She spent the next six years in prison, then joined her exiled husband in the U.S. Her imprisonment only raised her

A UYGUR DISCO in Hotan attracts young couples to a nightlife of their own. The scene belies the official Chinese portrait of Uygurs as “colorful, quaint folks,” says China scholar James Millward. “In the cities they are modern and worldly.” Many Uygurs also fight the separatist label. But unless more of Xinjiang’s wealth is shared and their culture is respected, more Uygurs will demand change.



status among her people, who regard her as the “mother of all Uygurs.”

She’s a grandmother, just over five feet tall, and she terrifies the Chinese authorities. Mentioning her name in Xinjiang brings swift and severe punishment. When I went with Ahun to his home in Kashgar’s Old City, he spoke freely of rebellion against China’s government, but when I mentioned Rebiya Kadeer, he froze. “If China finds this,” he said, pointing to my voice recorder and then reaching for my throat in mock vengeance, “on Judgment Day I will catch your neck.”

After the July riots, trucks with loudspeakers circled the public squares of Urumqi, proclaiming that the unrest had been organized by Kadeer from her office in Washington, D.C. Chinese officials accused her in news reports



around the globe and were said to be planning to tear down her trade centers. “The Chinese authorities are fearful of me because of what they have been doing to the Uyghur people,” she told me recently. In her office an enormous East Turkistan flag—symbol of a free Uyghur nation—hangs on one wall, and photos of her 11 children, two of whom are in prison, hang on another.

The Western world knows of the struggle for freedom by Tibetans largely because the Dalai Lama presents a warm and charismatic embodiment of his people. The Uyghurs have remained obscure, in part, because they have no such figure. But the Chinese government’s recent efforts to demonize Rebiya Kadeer have lifted her into a representative role. “I keep advocating for my people, for the self-determination of Uyghurs,”

she told me. Whether that means autonomy within China or a push for full independence depends on the government’s reaction, she said. “At the moment I’m trying to invite the Chinese authorities to come to the dialogue peacefully.”

Even as Kadeer spoke, another round of strife loomed in Xinjiang—rumors, allegations, protests—and she acknowledges that a peaceful resolution may be impossible. After seeing the region’s past and present through Hotan and Kashgar, we may be glimpsing its future in Urumqi: a sprawling city that serves Han migrants drawn by Xinjiang’s natural resources, where a Uyghur minority stays confined to its quarter.

And on an otherwise silent Monday afternoon, men detonate on the street from the sheer force of their rage. □



RESURRECTION ISLAND

Once a scene of slaughter, icy South Georgia is awash with life again.



A penguin-speckled iceberg floats
in frigid grandeur off South Georgia.
This remote British outpost in the far
South Atlantic is a haven for millions
of seabirds and seals.





Sinuuous for its size—up to 12 feet and more than a thousand pounds—the leopard seal is a formidable predator, its mouth often stained with the blood of penguins and other seals.



Giant petrels patrol the beach at St. Andrews Bay, thronged by king penguins and elephant seals. During the breeding season South Georgia hosts the densest mass of marine mammals on Earth.



BY KENNETH BROWER

PHOTOGRAPHS BY PAUL NICKLEN

South Georgia rises sheer and stark from the sea,

a hundred-mile arc of dark Antarctic peaks, ice fields, and hanging glaciers. From the deck of a ship, the island makes a startling apparition, like the Himalaya just emerged from the Flood. For a polar outpost so solid and austere, covered half by permanent snow and ice and half by bare rock and tundralike vegetation, South

Georgia is strangely chimerical. Its meanings are contrary and elusive. Its moods are mercurial, brightening one moment, darkening and spitting sleet the next, then brightening again. The island seems marked in some unusual way, simultaneously favored and cursed. Few spots on Earth are so full of ambiguity and paradox.

The first paradox for the visitor has to do with one's latitude of departure. To travelers arriving from the north, the island seems forbiddingly antipodal and cold. To travelers arriving from the south, voyaging up from the Antarctic Peninsula, the island seems almost tropically lush. (In Antarctica there are two native species of vascular plants; on South Georgia there are 26.) To the explorer Ernest Shackleton—whose ship *Endurance* was crushed nearly a century ago by Antarctic pack ice, who rallied his crew through 16 months of entrapment in the floes, and who escaped finally with five of his men in a small lifeboat, crossing 800 miles of mountainous seas to the whaling stations of South Georgia—that snowy island looked like paradise.

Last February photographer Paul Nicklen and

I retraced Shackleton's route. We left the Antarctic Peninsula and sailed, as Shackleton had, just offshore to the South Shetland Islands, from which the explorer had launched his desperate run for South Georgia. His lifeboat, *James Caird*, was 20 feet long. The cruise ship on which Nicklen and I hitched a ride, *National Geographic Explorer*, was 367 feet and 6,000 tons. Where Shackleton's little vessel was pounded by a hurricane and a succession of gales, our big ship enjoyed fair weather. I was beginning to feel cheated of the true Antarctic experience when we raised South Georgia, which greeted us with hurricane-force winds of 110 miles an hour.

The second paradox of South Georgia is the crazy changeability of its weather. The Southern Ocean, as some call the seas that encircle Antarctica, has, on average, the strongest winds on Earth. There is little to weaken them, for these far southern latitudes circumscribe the entire globe almost without interruption by land. Low-pressure areas are free to chase one another eastward around the bottom of the planet like a howling dog in pursuit of its tail.

South Georgia sometimes seems like a time-lapse film of weather—one of those frantic abridgments in which clouds boil across the sky while a stroboscopic flickering of light and

Kenneth Brower writes regularly about wildlife and wild places. Photographer Paul Nicklen's latest collection of Arctic images is titled Polar Obsession.



The wreck of the catcher boat *Petrel* lies stranded at the abandoned whaling station of Grytviken. *Petrel* and her sisters did their work too well, depleting some whale species and nearly exterminating the blue. By the 1960s there was little left to hunt.

shadow passes over the land. You sail into a bay in bright sunshine and air scrubbed clean by the ceaseless circumpolar wind. You really can see forever. The steep headlands are an intense, improbable green. Depth of field is infinite, from the kelp beds in the foreground to the snows of the peaks beyond. A glacier, cradled in its high cirque, sends a skein of streams down the rock wall, icy rivulets glittering so bright they hurt the eyes. Then, moments later, like Dorothy whirled back to Kansas, you look out on that same emerald Oz rendered suddenly in gray halftones. A new front has blown in. The sun

is just a dimly glowing patch of cloud across which flurries of snowflakes swirl and eddy, dark patterns against the glow. South Georgia suffers from a meteorological version of bipolar disorder.

The third paradox is historical. In bay after bay the backdrop is pristine—the trackless peaks, snows, and glaciers that form the spine of the island—while the foreground is tarnished by the wreckage of a whaling station, one ruin after another, rusting away above a pebbly beach reclaimed by penguins and seals. South Georgia is a virgin wilderness that lost its virginity

yet is becoming virginal again. Here paradox verges on miracle: The island, epicenter of one of the worst marine mammal massacres in history, now teems with multitudes on the scale the planet knew before the invention of the spear, the bow, and the gun.

Captain James Cook, after exploring South Georgia in 1775, dutifully reported an “island of ice” that he briefly mistook for the southern continent he had been sent to find. Then, fatefully, he went on to mention the extraordinary abundance of seals. Scarcely a decade later the first sealing vessels arrived. In the sealing season of 1800-1801, a single ship, *Aspasia*, out of New York—just one of 18 American and British sealers then working the island—brought back 57,000 pelts. The Antarctic fur seal, *Arctocephalus gazella*, would be hunted to the verge of extinction. The southern elephant seal too would be brought low, killed in great numbers for the oil rendered from its blubber.

Next came whalers. First they chased down slower whales such as rights, humpbacks, and sperm whales. Then, early in the 20th century, with the invention of fast, steam-powered catcher boats and explosive harpoons, they built whaling stations on South Georgia and turned their attention to the big, fast baleen species, the fin and blue whales. The largest whale ever recorded, a female blue more than 110 feet long, was hauled ashore at South Georgia’s Grytviken whaling station in 1912.

The 1920s saw the introduction of factory whaling ships that could catch and process whales on the high seas without needing shore stations. Grytviken and South Georgia’s other whaling bases slowly declined. For me, these ghost towns of rusty flensing platforms, boilers, chimneys, and whale-oil storage tanks were poignant. The year before, on assignment for this magazine, I had spent a month in the tropical Pacific with the largest remnant population of blue whales (see “Still Blue,” March 2009). I had come to understand the blue whale slaughter intellectually—that in just four decades we nearly extinguished the largest creature ever to live—and now I grasped it viscerally. Here was

the hard evidence in oxidizing steel that rang dully under my knuckles. The blue whale had disappeared into these giant tanks, arranged in long rows as at any refinery.

But just as sun follows sleet in South Georgia, so it is with the oil-tank blues. They are soon chased away by the reality of the present. It is the whaling stations that are now extinct. It is



the sealers who are long gone. Most of the victim species have come back strong—the blue whale being a notable exception—and today these rusting death camps are mobbed by life.

A WHITE WALL three feet tall—the massed shirt-fronts of a phalanx of king penguins—greet a skiff or Zodiac approaching the beach at St. Andrews Bay. The white wall here was once 65 feet tall and made of ice—the terminus of the Cook Glacier. But for the past 30 years all three glaciers of St. Andrews have been in galloping retreat, and penguins have stepped in to fill the void. Walk up to the beach crest and the view opens up: to the south, penguins forever, a rookery of 150,000 pairs, the largest king penguin colony on South Georgia. The birds crowd shoulder to shoulder, except where glacial rivers clear channels through the rookery. Along the beach where the Cook Glacier once calved great pinnacles of ice into the sea, the rookery now calves flotillas of king penguins. They raft sociably for a while, then melt away to go fishing.

The king is the second largest penguin, about

A CRESCENT OF MOUNTAINS that spire to nearly 10,000 feet, South Georgia is a lost piece of the Andes. Pushed far east by tectonic forces, the island rests in a vital spot for marine life—north of the zone where sea ice forms, yet still bathed in a food-rich current streaming up from Antarctica.



a foot shorter than the emperor. Like other penguins, it undergoes an annual molt, replacing all its feathers in a few weeks. At the time of my visit, 10 to 15 percent of the adults were in the grip of this transformation. Amid the multitudes in sleek evening garb, the molting birds had the look of disheveled bounders or tipplers in moth-eaten raccoon coats.

Mixed with the penguin multitudes were many hundreds of Antarctic fur seals, mostly pups, sleeping or jousting or playing tag in small gangs. Young seals long ago reached a truce with penguins but not with humans, and the pups like to make bluff charges at people. The attacks are entirely bogus. Clap your hands, shout "Stop!" and the pup instantly loses courage and veers off sheepishly. Elephant seal cows—as many as 6,000 in October, at the height of their calving season—add to the crush at St. Andrews Bay.

Both fur and elephant seals have made spectacular rebounds. By the early 1900s, after a century of hunting, only a relict population of Antarctic fur seals survived on South Georgia. Today they number in the low millions, the vast majority of which breed on South Georgia. Likewise, hundreds of thousands of southern elephant seals come to the island each summer to breed and to rear their young.

South Georgia's king penguin populations too are soaring. In 1925 only 1,100 kings were counted at St. Andrews Bay; since then there has been a 300-fold increase in the rookery. A gathering of 300,000 penguins would usually raise a deafening roar of debate and protest and recrimination, but at the time of my visit the nesting birds were relatively laconic. There was no great din at St. Andrews Bay; the loudest noise here was visual, the sheer spectacle of numbers.

In places, the rookery's soil seemed composed mostly of the narrow white barbs of breast feathers, spiky with barbules, and loose feathers lay in drifts on the ground. Gusting winds sent ground storms of feathers scurrying seaward. Seen from a distance, the effect was like heat shimmer over the whole rookery. Somehow these feather blizzards, more even than the

legions of birds that generate them, testify to the exuberance of life on South Georgia. Watching, I was moved almost to tears. I grew up in a family where environmentalism was religion; here, in this rookery, for someone of my faith, was life as it is supposed to be, in all its amplitude.

This sort of epiphany waits in almost every bay and inlet of South Georgia. Sometimes the animal multitudes are horizontal, as on Salisbury Plain, a glacial outwash delta densely colonized by king penguins, fur and elephant seals, and kelp gulls. Other times they are vertical, as at Elsehul, where the shores and lower slopes are thick with penguins, fur seals, shags, and sheathbills, while the steep, tussocky headlands are dense rookeries of grey-headed, black-browed, wandering, and light-mantled sooty albatrosses as well as skuas and Antarctic terns.

THIS PROFUSION OF LIFE has a secret: South Georgia is a relatively temperate island in the path of a seasonal swarm of krill borne up by currents from the Antarctic Peninsula—a living river of small, red, shrimplike crustaceans. If South Georgia has a special dispensation, it is this river of krill. It fed the largest herds of fur seals and great whales on Earth in the ages before the sealers and whalers came. Today it is fueling the astonishing resurrection of the Antarctic fur seal, as well as the slow but steady recovery of several whale species.

Periodically, once or twice a decade, the river of krill seems to go astray. The year 2004 was a poor krill year at South Georgia, and 2009 has been a very bad one. A trend often masquerades as a cycle at the start, and evidence suggests that these scarce krill years may foreshadow a new South Georgia. A 2004 paper by Angus Atkinson of the British Antarctic Survey presented evidence of a 30-year decline in krill over a wide sector that holds more than half the krill stocks in the Southern Ocean.

Krill, especially the larvae, are dependent in winter on sea ice, and for the past few decades this layer of frozen seawater has been shrinking in some parts of the Antarctic (although overall it has increased slightly). Earlier this year a



A light-mantled sooty albatross looks down on Gold Harbour. Individuals of the species can live past 40, so this nesting bird may have witnessed a change in view. In 1985 a glacier buried this shore; since then the ice has retreated a half mile inland.

team of oceanographers reported that the seas to the west of the Antarctic Peninsula have been warming many times faster than the world average over the past 50 years. The warming is strongest near the surface and in winter—not good news for winter sea ice.

Neither is the news good for Antarctica's ice shelves—glaciers that extend into the ocean. Much of the vast Larsen Ice Shelf collapsed in 2002, and the smaller Wordie Ice Shelf vanished last April. If the magnifying glass of global warming has a focal point, it would seem to be the seas of the western Antarctic Peninsula,

headwaters for South Georgia's river of krill.

On the day I left the island, the ship overtook an iceberg at sunset. It was the most beautiful thing I had ever seen. The glistening white wall towered above us, sheer as El Capitan and lovely in the last light of day. Icebergs have long been icons of the great white continent—Antarctica in microcosm. At a time when sprawling shelves of ice are disintegrating, this berg seemed to signify more. It was a last paradox. In this new era of climate change, icebergs are doubly symbolic, both of the pristine beauty of the Antarctic region and of the trouble that lies ahead. □



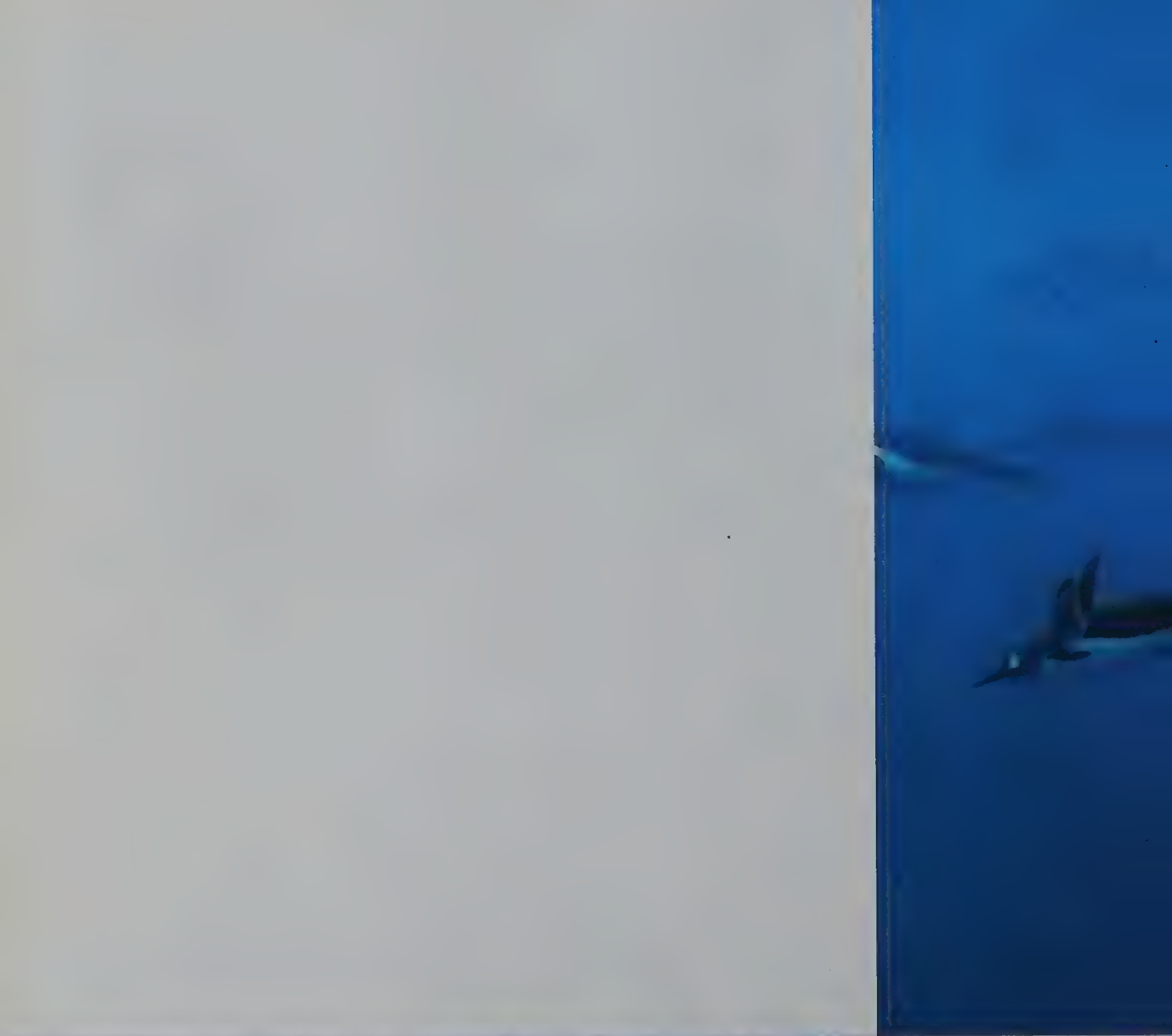
Soaring on seven-foot wings, a pair of light-mantled sooty albatrosses cruise the nesting cliffs of Gold Harbour. Nearly a third of all the birds of this species nest on South Georgia.





A bull elephant seal emerges from the surf at Fortuna Bay. During breeding season South Georgia's beaches become battlegrounds as big bulls engage in bloody duels for dominance.







A squadron of gentoo penguins (above) wings through the waters of Drygalski Fjord. Unlike true Antarctic penguins, the gentoo prefers more temperate climes. As oceans warm, this species is prospering, expanding its range southward. But there's a catch: Swarms of krill (left), the gentoo's primary food and a cornerstone of the entire Antarctic food chain, feed on phytoplankton that grows on the underside of sea ice. In recent years ice cover has been shrinking in waters west of the Antarctic Peninsula—source of South Georgia's krill.

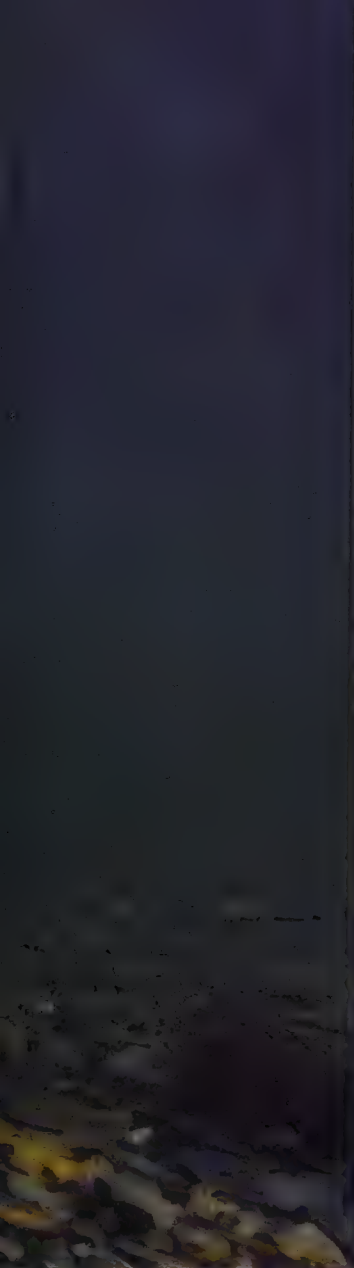


Gentoo and chinstrap penguins look out
on a flotilla of small icebergs in Cooper
Bay. Chinstrap ranks were thinned by an
outbreak of avian cholera in 2004.





Lolling in a glacier-fed river (above) or keeping cool under a flipperful of sand (right), southern elephant seals can be mellow, like these two bulls. But photographer Paul Nicklen was attacked while snorkeling off a breeding beach. “One tried to crush me,” he says of a four-ton male. Using the housing of his underwater camera as a shield, he managed to escape with only sprained wrists. Two centuries ago, such encounters were almost always fatal—for the seal—but no longer. Once a killing ground, South Georgia is now a sanctuary.







THROUGHOUT HISTORY, ONLY
ONE EARTH HAS BEEN KNOWN
TO EXIST IN THE UNIVERSE.
SOON THERE MAY BE ANOTHER.
AND ANOTHER. AND ANOTHER.

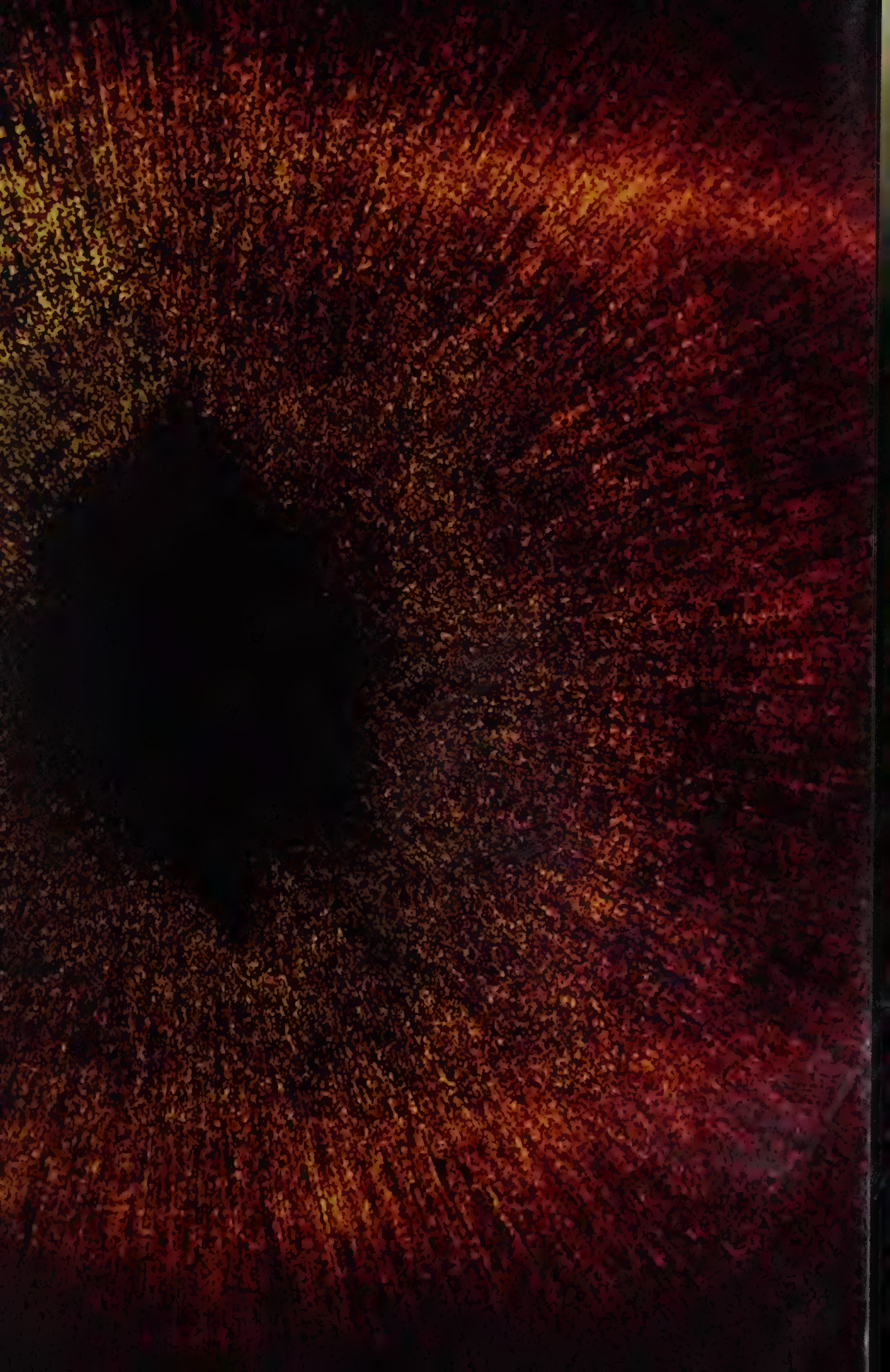
Worlds apart

Like home? The four planets in the Gliese system, orbiting a star dimmer than our sun some 20 light-years away, include the newly found Gliese 581 e (foreground)—a rocky place just twice Earth's mass—and 581 d, which could harbor liquid water.

ART BY DANA BERRY
SOURCES: MICHEL MAYOR, GENEVA UNIVERSITY; GEOFF MARCY, UC BERKELEY



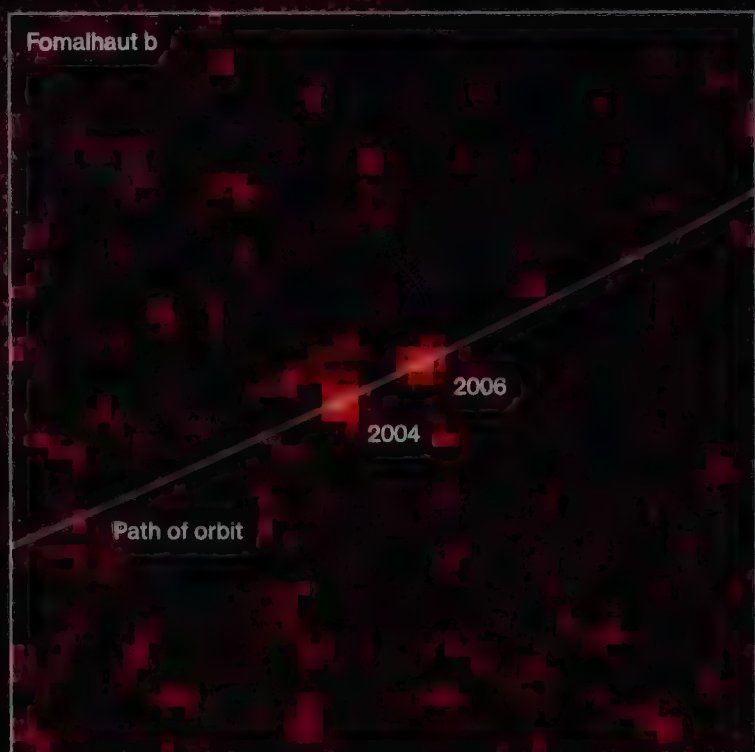
A dust ring 25 billion miles across veils the planet Fomalhaut b (in small box at right). The Hubble Space Telescope captured this image, one of the first direct images of a planet outside our solar system, by blocking the glare of the star (at center).



BODY IN MOTION

The distance Fomalhaut b traveled between Hubble's initial image and one in 2006 (composite below) let scientists calculate the length of its orbit—872 years—around the star Fomalhaut. A gas giant, the planet is no more than three times heavier than Jupiter.

Fomalhaut b



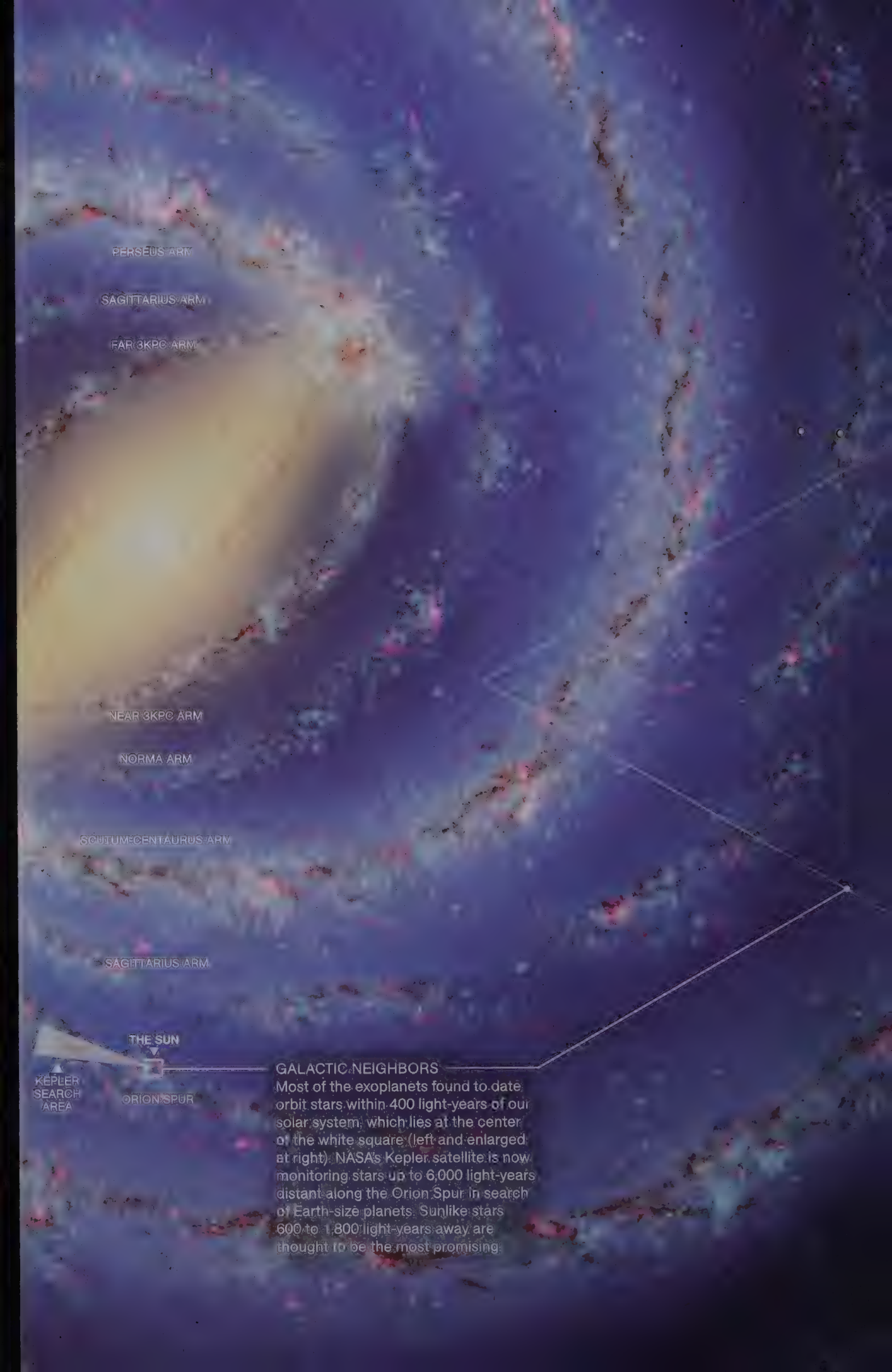
Searching space

"There will be nothing to hinder an infinity of worlds," wrote Greek philosopher Epicurus some 23 centuries ago. Now, with ever clearer views of distant space, such thinking is back in vogue. More than 370 planets outside our solar system have already been discovered. An overhead view of our Milky Way galaxy (artist's conception, right) gleams with more than 100 billion stars—and billions of those are likely to possess planetary systems of their own. Astronomers zooming in on those points of light with more sensitive instruments expect to discover other Earthlike planets—some, perhaps, with all the makings for life.

THE MILKY WAY

The arms of our galaxy spiral off a central bar of stars 27,000 light-years long. Our solar system lies in a partial arm, the Orion Spur. In this view, based on infrared images from NASA's Spitzer Space Telescope, regions where new stars are forming appear in red.

OUTER ARM



PERSEUS ARM

SAGITTARIUS ARM

FAR 3KPC ARM

NEAR 3KPC ARM

NORMA ARM

SCUTUMCENTAURUS ARM

SAGITTARIUS ARM

THE SUN

KEPLER
SEARCH
AREA

ORION SPUR

GALACTIC NEIGHBORS

Most of the exoplanets found to date orbit stars within 400 light-years of our solar system, which lies at the center of the white square (left and enlarged at right). NASA's Kepler satellite is now monitoring stars up to 6,000 light-years distant along the Orion Spur in search of Earth-size planets. Sunlike stars 600 to 1,800 light-years away are thought to be the most promising.

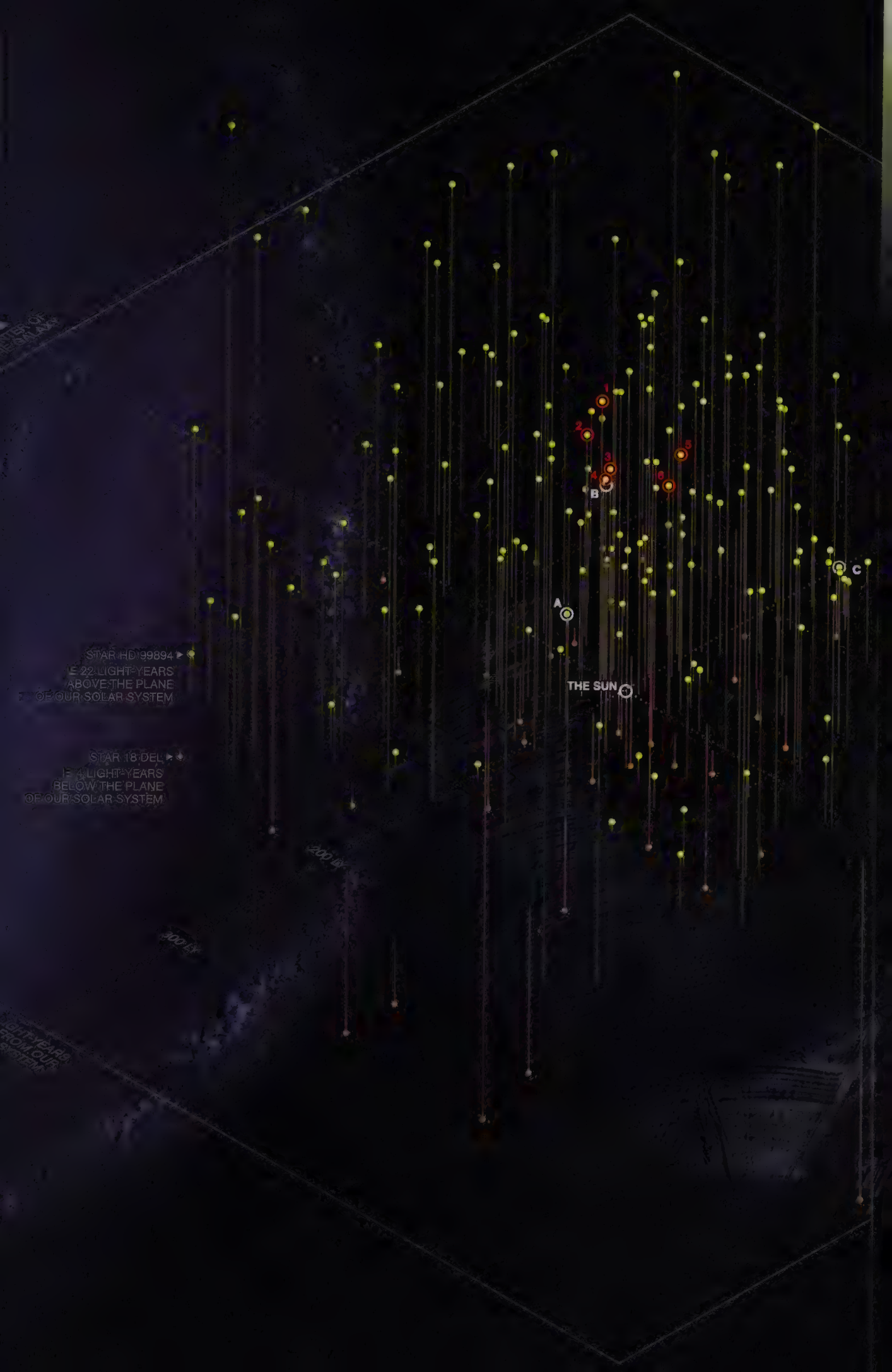
PLAN OF
THE GALAXY

STAR HD 198894 ▶
122 LIGHT-YEARS
ABOVE THE PLANE
OF OUR SOLAR SYSTEM

STAR 18 DEL ▶
17 LIGHT-YEARS
BELOW THE PLANE
OF OUR SOLAR SYSTEM

THE SUN

100 LIGHT-YEARS
FROM OUR
SYSTEM



The known planets

By late 2009, the rapidly growing number of exoplanets hit 373, plotted here by their mass and distance from Earth. Most already discovered are larger than Jupiter, which makes them easiest to find. Advances in detection in the past few years have identified 13 small, rocky planets close to Earth's size orbiting sunlike stars (in red).

EXOPLANET MASS



EXOPLANETS BY MASS

POSSIBLE TERRESTRIAL PLANET
LESS THAN 10 EARTH MASSES

FIRST CONFIRMED
EXOPLANET ORBITING
SUNLIKE STAR, 51 PEGASI

FOMALHAUT b
PLANETS OF GLIESE 581

SOLAR
SYSTEM

10
LIGHT-YEARS
AWAY

EARTH

SATURN
95 EARTHS

JUPITER
318 EARTHS

MORE MASSIVE THAN 10 JUPITERS
(EARTHS), MAY BE FAILED STARS
OR BROWN DWARFS.

HD 43848 b
THE MOST MASSIVE
(7,946 EARTHS)

TRUE GIANTS

Colossal Saturn and Jupiter are punts compared with the current lineup of exoplanets. The largest for which a diameter has been measured is CT Cha b (artist's conception below). More than twice Jupiter's diameter and 17 times its mass, it orbits a young star, CT Cha, in the constellation Chamaeleon.

CT CHA b
5,403 EARTHS
MORE THAN 500 LIGHT-YEARS AWAY



FINDING EXOPLANETS

Few of the planets discovered outside our solar system have been directly observed. Astrophysicists detect them and gather a remarkable amount of information by interpreting very subtle changes they cause in their star.

DOPPLER WOBBLE

A star orbited by a planet will wobble because of gravitational pull. As the star moves slightly toward and then away from Earth, its light shifts in the spectrum to shorter or longer wavelengths. Measuring the degree of spectral shift reveals the planet's minimum mass.



TRANSITS

A planet passing in front of a star minutely dims its light, revealing the planet's diameter, orbital period, and sometimes atmosphere.

ASTROMETRY

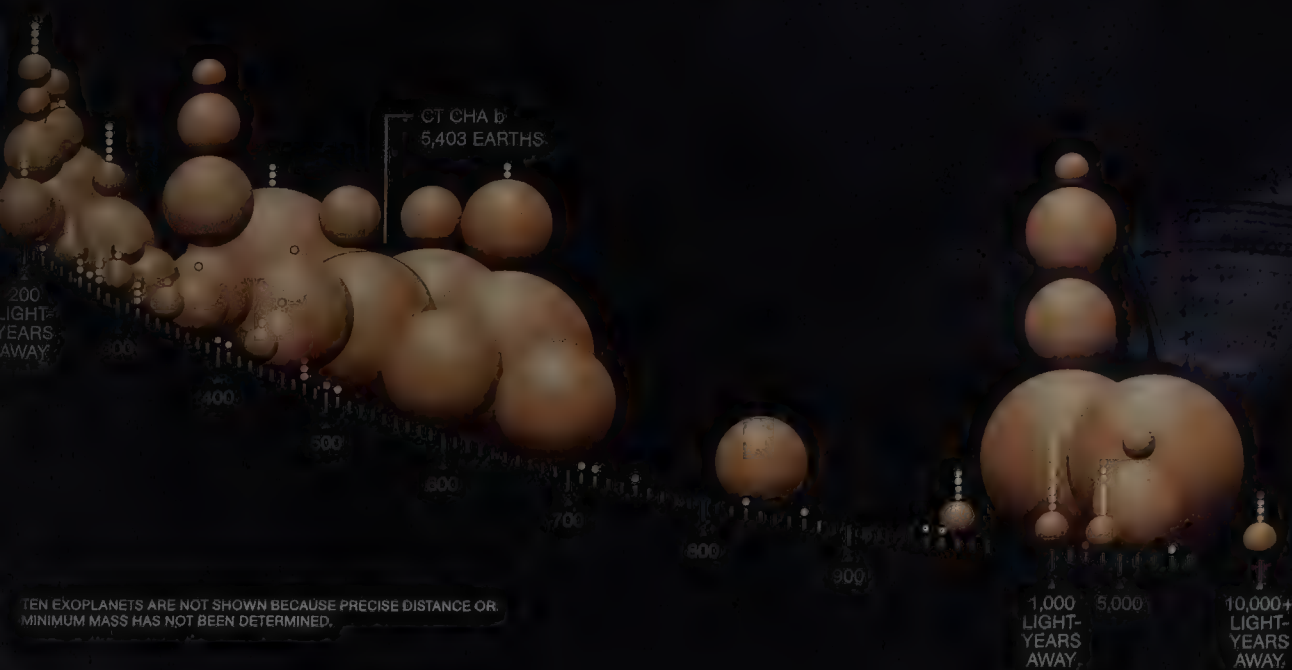
The gravity of a very large planet pulls its star from side to side, far enough to be measured against background stars.

DIRECT IMAGING

Blocking a star's light has yielded images of 11 planets, including Fomalhaut b and CT Cha b.

GRAVITATIONAL MICROLENSING

If a star and planet pass in front of another star, their gravitational fields act as a lens, bending light from the far star in a distinctive way.



The launch that sent NASA's Kepler spacecraft streaking starward last March drew a crowd just south of Florida's Cape Canaveral. Kepler's mission is to keep watch over more than 100,000 candidate stars for signs of Earth-size planets.





WORLDS APART

Seeking new earths

BY TIMOTHY FERRIS

It took humans thousands of years to explore our own planet and centuries to comprehend our neighboring planets, but nowadays new worlds are being discovered every week. To date, astronomers have identified more than 370 “exoplanets,” worlds orbiting stars other than the sun. Many are so strange as to confirm the biologist J. B. S. Haldane’s famous remark that “the universe is not only queerer than we suppose, but queerer than we *can* suppose.” There’s an Icarus-like “hot Saturn” 260 light-years from Earth, whirling around its parent star so rapidly that a year there lasts less than three days. Circling another star 150 light-years out is a scorched “hot Jupiter,” whose upper atmosphere is being blasted off to form a gigantic, comet-like tail. Three benighted planets have been found orbiting a pulsar—the remains of a once mighty star shrunk into a spinning atomic nucleus the size of a city—while untold numbers of worlds have evidently fallen into their suns or been flung out of their systems to become “floaters” that wander in eternal darkness.

Amid such exotica, scientists are eager for a hint of the familiar: planets resembling Earth,

orbiting their stars at just the right distance—neither too hot nor too cold—to support life as we know it. No planets quite like our own have yet been found, presumably because they're inconspicuous. To see a planet as small and dim as ours amid the glare of its star is like trying to see a firefly in a fireworks display; to detect its

WE BELIEVE THAT BILLIONS OF SUCH PLANETS MUST EXIST AND THAT THEY HOLD THE PROMISE OF EXPANDING NOT ONLY THE SCOPE OF HUMAN KNOWLEDGE BUT ALSO THE RICHNESS OF THE HUMAN IMAGINATION.

gravitational influence on the star is like listening for a cricket in a tornado. Yet by pushing technology to the limits, astronomers are rapidly approaching the day when they can find another Earth and interrogate it for signs of life.

Only 11 exoplanets, all of them big and bright and conveniently far away from their stars, have as yet had their pictures taken. Most of the others have been detected by using the spectroscopic Doppler technique, in which starlight is analyzed for evidence that the star is being tugged ever so slightly back and forth by the gravitational pull of its planets. In recent years astronomers have refined the Doppler technique so exquisitely that they can now tell when a star is pulled from its appointed rounds by only one meter a second—about human walking speed. That's sufficient to detect a giant planet in a big orbit, or a small one if it's very close to its star, but not an Earth at anything like our Earth's 93-million-mile distance from its star. The Earth tugs the sun around at only one-tenth

walking speed, or about the rate that an infant can crawl; astronomers cannot yet prize out so tiny a signal from the light of a distant star.

Another approach is to watch a star for the slight periodic dip in its brightness that will occur should an orbiting planet circle in front of it and block a fraction of its light. At most a tenth of all planetary systems are likely to be oriented so that these mini-eclipses, called transits, are visible from Earth, which means that astronomers may have to monitor many stars patiently to capture just a few transits. The French COROT satellite, now in the third and final year of its prime mission, has discovered seven transiting exoplanets, one of which is only 70 percent larger than Earth.

The United States' Kepler satellite is COROT's more ambitious successor. Launched from Cape Canaveral last March, Kepler is essentially just a big digital camera with a .95-meter aperture and a 95-megapixel detector. It makes wide-field pictures every 30 minutes, capturing the light of more than 100,000 stars in a single patch of sky between the bright stars Deneb and Vega. Computers on Earth monitor the brightness of all those stars over time, alerting humans when they detect the slight dimming that could signal the transit of a planet.

Because that dimming can be mimicked by other phenomena, such as the pulsations of a variable star or a large sunspot moving across a star's surface, the Kepler scientists won't announce the presence of a planet until they have seen it transit at least three times—a wait that may be only a few days or weeks for a planet rapidly circling close to its star but years for a terrestrial twin. By combining Kepler results with Doppler observations, astronomers expect to determine the diameters and masses of transiting planets. If they manage to discover a rocky planet roughly the size of Earth orbiting in the habitable zone—not so close to the star

Veteran stargazer Timothy Ferris writes from his own observatory in California. His new book, The Science of Liberty, will be published in February.

that the planet's water has been baked away, nor so far out that it has frozen into ice—they will have found what biologists believe could be a promising abode for life.

The best hunting grounds may be dwarf stars, smaller than the sun. Such stars are plentiful (seven of the ten stars nearest to Earth are M dwarfs), and they enjoy long, stable careers, providing a steady supply of sunlight to any life-bearing planets that might occupy their habitable zones. Most important for planet hunters, the dimmer the star, the closer in its habitable zone lies—dim dwarf stars are like small campfires, where campers must sit close to be comfortable—so transit observations will pay off more quickly. A close-in planet also exerts a stronger pull on its star, making its presence easier to confirm with the Doppler method. Indeed, the most promising planet yet found—the “super Earth” Gliese 581 d, seven times Earth's mass—orbits in the habitable zone of a red dwarf star only a third the mass of the sun.

Should Earthlike planets be found within the habitable zones of other stars, a dedicated space telescope designed to look for signs of life there might one day take a spectrum of the light coming from each planet and examine it for possible biosignatures such as atmospheric methane, ozone, and oxygen, or for the “red edge” produced when chlorophyll-containing photosynthetic plants reflect red light. Directly detecting and analyzing the planet's own light, which might be one ten-billionth as bright as the star's, would be a tall order. But when a planet transits, starlight shining through the atmosphere could reveal clues to its composition that a space telescope might be able to detect.

While grappling with the daunting technological challenge of performing a chemical analysis of planets they cannot even see, scientists searching for extraterrestrial life must keep in mind that it may be very different from life here at home. The lack of the red edge, for instance, might not mean a terrestrial exoplanet is lifeless: Life thrived on Earth for billions of years before land plants appeared and populated the continents. Biological evolution is so inherently

unpredictable that even if life originated on a planet identical to Earth at the same time it did here, life on that planet today would almost certainly be very different from terrestrial life.

As the biologist Jacques Monod once put it, life evolves not only through necessity—the universal workings of natural law—but also through chance, the unpredictable intervention of countless accidents. Chance has reared its head many times in our planet's history, dramatically so in the many mass extinctions that wiped out millions of species and, in doing so, created room for new life-forms to evolve. Some of these baleful accidents appear to have been caused by comets or asteroids colliding with Earth—most recently the impact, 65 million years ago, that killed off the dinosaurs and opened up opportunities for the distant ancestors of human beings. Therefore scientists look not just for exoplanets identical to the modern Earth, but for planets resembling the Earth as it used to be or might have been. “The *modern* Earth may be the worst template we could use in searching for life elsewhere,” notes Caleb Scharf, head of Columbia University's Astrobiology Center.

It was not easy for earlier explorers to plumb the depths of the oceans, map the far side of the moon, or discern evidence of oceans beneath the frozen surfaces of Jovian moons, and it will not be easy to find life on the planets of other stars. But we now have reason to believe that billions of such planets must exist and that they hold the promise of expanding not only the scope of human knowledge but also the richness of the human imagination.

For thousands of years we humans knew so little about the universe that we were apt to celebrate our imaginations and denigrate reality. (As Spanish philosopher Miguel de Unamuno wrote, the mysticism of the religious visionaries of old arose from an “intolerable disparity between the hugeness of their desire and the smallness of reality.”) Now, with advances in science, it has become gallingly evident that nature's creativity outstrips our own. The curtain is going up on countless new worlds with stories to tell. □

**THEY GROW NO FOOD, RAISE NO LIVESTOCK, AND LIVE WITHOUT
RULES OR CALENDARS. THEY ARE LIVING A HUNTER-GATHERER EXISTENCE
THAT IS LITTLE CHANGED FROM 10,000 YEARS AGO. WHAT DO
THEY KNOW THAT WE'VE FORGOTTEN?**

THE HADZA

BY MICHAEL FINKEL

PHOTOGRAPHS BY MARTIN SCHOELLER

Like his ancestors, young Nija will grow up to roam
the wildlands around Lake Eyasi in northern Tanzania—if outside
pressures don't curtail his people's freedom first.





Long vistas and the dry season's
withered vegetation enable keen
eyes to spot game miles away. From
a wind-bowed tree on a ridge, a man
named Mahiya peers across rough
terrain where Hadza bands range.





Everyone carries something from a kill site back to camp. For Kapala, it's the kudu's head atop his own. His group, composed of extended family and friends, will feast until all the meat is gone.



"I'M HUNGRY," SAYS ONWAS, SQUATTING BY HIS FIRE, BLINKING PLACIDLY THROUGH THE SMOKE. THE MEN BESIDE HIM MURMUR IN ASSENT. IT'S LATE AT NIGHT, DEEP IN THE EAST AFRICAN BUSH.

Singing, a rhythmic chant, drifts over from the women's camp. Onwas mentions a tree he spotted during his daytime travels. The men around the fire push closer. It is in a difficult spot, Onwas explains, at the summit of a steep hill that rises from the grassy plain. But the tree, he adds, spreading his arms wide like branches, is heavy with baboons. There are more murmurs. Embers rise to a sky infinite with stars. And then it is agreed. Everyone stands and grabs his hunting bow.

Onwas is an old man, perhaps over 60—years are not a unit of time he uses—but thin and fit in the Hadza way. He's maybe five feet tall. Across his arms and chest are the hieroglyphs of a lifetime in the bush: scars from hunts, scars from snakebites, scars from arrows and knives and scorpions and thorns. Scars from falling out of a baobab tree. Scars from a leopard attack. Half his teeth remain. He is wearing tire-tread sandals and tattered brown shorts. A hunting knife is strapped to his hip, in a sheath made of dik-dik hide. He's removed his shirt, as have

most of the other men, because he wants to blend into the night.

Onwas looks at me and speaks for a few moments in his native language, Hadzane. To my ear it sounds strangely bipolar—lilting and gentle for a phrase or two, then jarring and percussive, with tongue clicks and glottic pops. It's a language not closely related to any other that still exists: to use the linguists' term, an isolate.

I have arrived in the Hadza homeland in northern Tanzania with an interpreter, a Hadza woman named Mariamu. She is Onwas's niece. She attended school for 11 years and is one of only a handful of people in the world who can speak both English and Hadzane. She interprets Onwas's words: Do I want to come?

Merely getting this far, to a traditional Hadza encampment, is not an easy task. Years aren't the only unit of time the Hadza do not keep close track of—they also ignore hours and days and weeks and months. The Hadza language doesn't have words for numbers past three or

Well past his prime as a hunter, but in full flower as a storyteller, Onwas is the father figure for one of the many groups of Hadza who still follow an ancient hunter-gatherer lifestyle.



four. Making an appointment can be a tricky matter. But I had contacted the owner of a tourist camp not far outside the Hadza territory to see if he could arrange for me to spend time with a remote Hadza group. While on a camping trip in the bush, the owner came across Onwas and asked him, in Swahili, if I might visit. The Hadza tend to be gregarious people, and Onwas readily agreed. He said I'd be the first foreigner ever to live in his camp. He promised to send his son to a particular tree at the edge of the bush to meet me when I was scheduled to arrive, in three weeks.

Sure enough, three weeks later, when my interpreter and I arrived by Land Rover in the bush, there was Onwas's son Ngaola waiting for us. Apparently, Onwas had noted the stages of the moon, and when he felt enough time had passed, he sent his son to the tree. I asked Ngaola if he'd waited a long time for me. "No," he said. "Only a few days."

At first, it was clear that everyone in camp—about two dozen Hadza, ranging from infants to grandparents—felt uncomfortable with my presence. There was a lot of staring, some nervous laughs. I'd brought along a photo album, and passing it around helped mitigate the awkwardness. Onwas was interested in a picture of my cat. "How does it taste?" he asked. One photo captured everyone's attention. It was of me participating in a New Year's Day polar bear swim, leaping into a hole cut in a frozen lake. Hadza hunters can seem fearless; Onwas regularly sneaks up on leopards and races after giraffes. But the idea of winter weather terrified him. He ran around camp with the picture, telling everyone I was a brave man, and this helped greatly with my acceptance. A man who can leap into ice, Onwas must have figured, is certainly a man who'd have no trouble facing a wild baboon. So on the third night of my stay, he asks if I want to join the hunting trip.

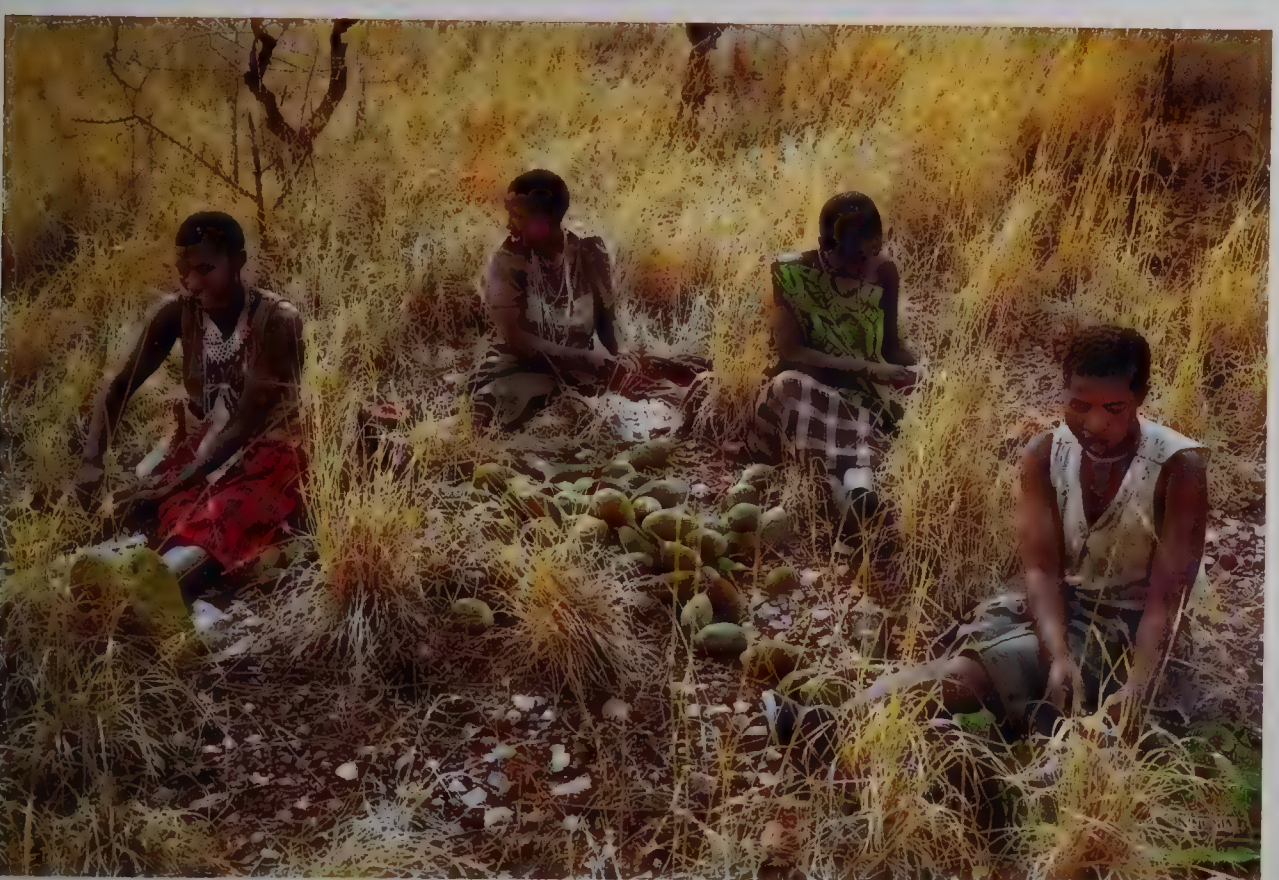
I do. I leave my shirt on—my skin does not blend well with the night—and I follow Onwas and ten other hunters and two younger boys out of camp in a single-file line. Walking through Hadza country in the dark is challenging; thornbushes and spiked acacia trees dominate the terrain, and even during the day there is no way to avoid being jabbed and scratched and punctured. A long trek in the Hadza bush can feel like receiving a gradual full-body tattoo. The Hadza spend a significant portion of their rest time digging thorns out of one another with the tips of their knives.

At night the thorns are all but invisible, and navigation seems impossible. There are no trails and few landmarks. To walk confidently in the bush, in the dark, without a flashlight, requires the sort of familiarity one has with, say, one's own bedroom. Except this is a thousand-square-mile bedroom, with lions and leopards and hyenas prowling in the shadows.

For Onwas such navigation is no problem. He has lived all his life in the bush. He can start a fire, twirling a stick between his palms, in less than 30 seconds. He can converse with a honeyguide bird, whistling back and forth, and be led directly to a teeming beehive. He knows everything there is to know about the bush and virtually nothing of the land beyond. One time I showed Onwas a map of the world. I spread it open on the dirt and anchored the corners with stones. A crowd gathered. Onwas stared. I pointed out the continent of Africa, then the country of Tanzania, then the region where he lived. I showed him the United States.

I asked him what he knew about America—the name of the president, the capital city. He said he knew nothing. He could not name the leader of his own country. I asked him, as politely as possible, if he knew anything about any country. He paused for a moment, evidently deep in

Men butcher small antelope called dik-diks near a hut in a traditional camp (top right). While men hunt, women crack baobab shells for the tart flesh within. Women's contributions of fruits and tubers are more vital than game in the Hadza diet. Several hundred out of a total Hadza population of about a thousand subsist almost exclusively on what they forage—despite long exposure to nearby agricultural societies.



WHAT THE HADZA APPEAR TO OFFER—AND WHY THEY ARE OF GREAT INTEREST TO ANTHROPOLOGISTS—IS A GLIMPSE OF WHAT LIFE MAY HAVE BEEN LIKE BEFORE THE BIRTH OF AGRICULTURE.

thought, then suddenly shouted, “London!” He couldn’t say precisely what London was. He just knew it was someplace not in the bush.

About a thousand Hadza live in their traditional homeland, a broad plain encompassing shallow, salty Lake Eyasi and sheltered by the ramparts of the Great Rift Valley. Some have moved close to villages and taken jobs as farmhands or tour guides. But approximately one-quarter of all Hadza, including those in Onwas’s camp, remain true hunter-gatherers. They have no crops, no livestock, no permanent shelters. They live just south of the same section of the valley in which some of the oldest fossil evidence of early humans has been found. Genetic testing indicates that they may represent one of the primary roots of the human family tree—perhaps more than 100,000 years old.

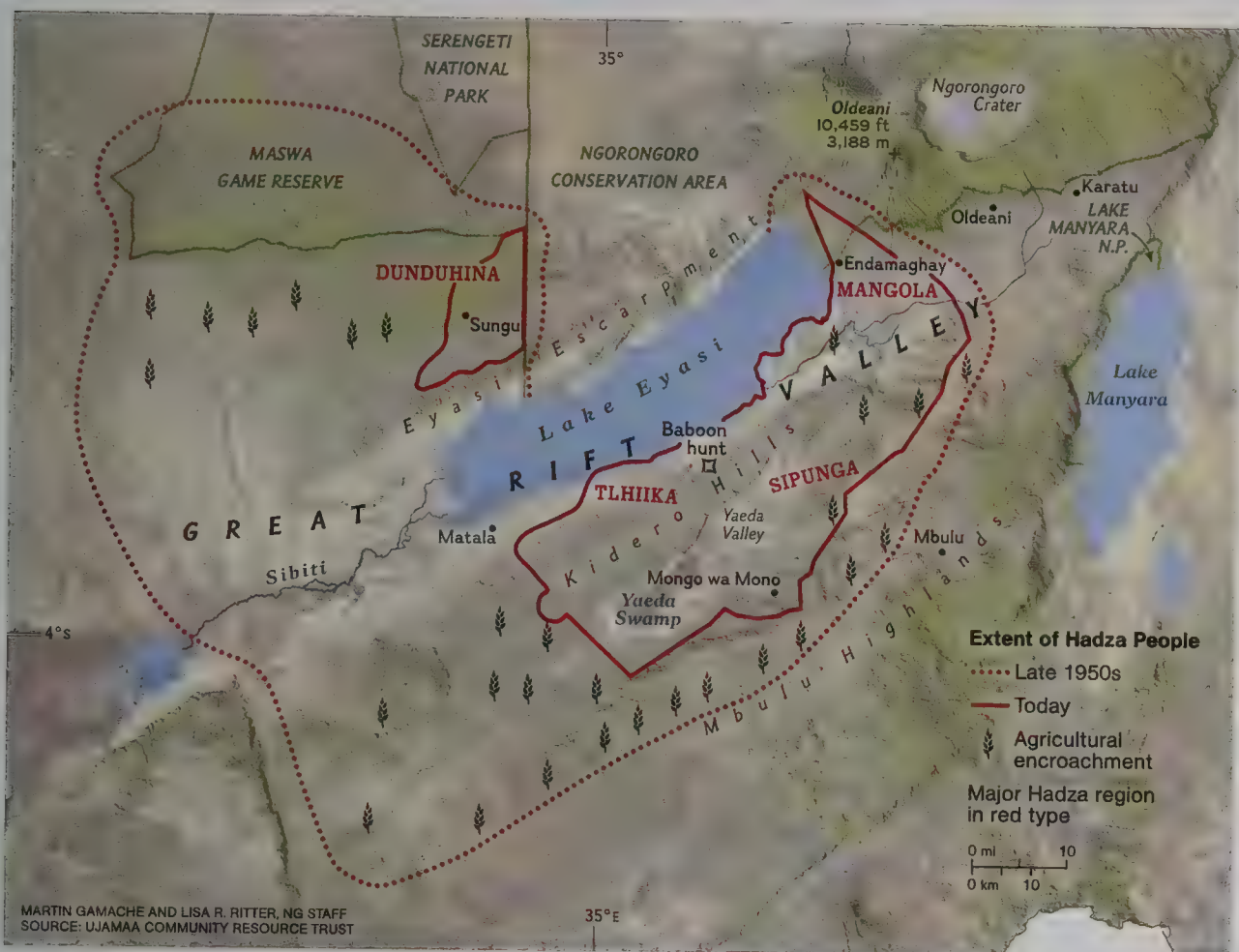
What the Hadza appear to offer—and why they are of great interest to anthropologists—is a glimpse of what life may have been like before the birth of agriculture 10,000 years ago. Anthropologists are wary of viewing contemporary hunter-gatherers as “living fossils,” says Frank Marlowe, a Florida State University professor of anthropology who has spent the past 15 years studying the Hadza. Time has not stood still for them. But they have maintained their foraging lifestyle in spite of long exposure to surrounding agriculturalist groups, and, says Marlowe, it’s possible that their lives have changed very little over the ages.

For more than 99 percent of the time since

the genus *Homo* arose two million years ago, everyone lived as hunter-gatherers. Then, once plants and animals were domesticated, the discovery sparked a complete reorganization of the globe. Food production marched in lockstep with greater population densities, which allowed farm-based societies to displace or destroy hunter-gatherer groups. Villages were formed, then cities, then nations. And in a relatively brief period, the hunter-gatherer lifestyle was all but extinguished. Today only a handful of scattered peoples—some in the Amazon, a couple in the Arctic, a few in Papua New Guinea, and a tiny number of African groups—maintain a primarily hunter-gatherer existence. Agriculture’s sudden rise, however, came with a price. It introduced infectious-disease epidemics, social stratification, intermittent famines, and large-scale war. Jared Diamond, the UCLA professor and writer, has called the adoption of agriculture nothing less than “the worst mistake in human history”—a mistake, he suggests, from which we have never recovered.

The Hadza do not engage in warfare. They’ve never lived densely enough to be seriously threatened by an infectious outbreak. They have no known history of famine; rather, there is evidence of people from a farming group coming to live with them during a time of crop failure. The Hadza diet remains even today more stable and varied than that of most of the world’s citizens. They enjoy an extraordinary amount of leisure time. Anthropologists have estimated that they “work”—actively pursue food—four to six hours a day. And over all these thousands of years, they’ve left hardly more than a footprint on the land.

Traditional Hadza, like Onwas and his camp mates, live almost entirely free of possessions. The things they own—a cooking pot, a water container, an ax—can be wrapped in a blanket and carried over a shoulder. Hadza women gather berries and baobab fruit and dig edible tubers. Men collect honey and hunt. Nighttime baboon stalking is a group affair, conducted



SHIFTING GROUND The Hadza, who once moved freely over 4,000-plus square miles of the Great Rift Valley, are down to a quarter of their homeland as farms and livestock expand. Some Tanzanians see the group as an embarrassment for a modernizing nation.



only a handful of times each year; typically, hunting is a solo pursuit. They will eat almost anything they can kill, from birds to wildebeest to zebras to buffalo. They dine on warthog and bush pig and hyrax. They love baboon; Onwas joked to me that a Hadza man cannot marry until he has killed five baboons. The chief exception is snakes. The Hadza hate snakes.

The poison the men smear on their arrowheads, made of the boiled sap of the desert rose,

is powerful enough to bring down a giraffe. But it cannot kill a full-grown elephant. If hunters come across a recently dead elephant, they will crawl inside and cut out meat and organs and fat and cook them over a fire. Sometimes, rather than drag a large animal back to camp, the entire camp will move to the carcass.

Hadza camps are loose affiliations of relatives and in-laws and friends. Each camp has a few core members—Onwas's two sons, Giga and Ngaola, are often with him—but most others come and go as they please. The Hadza recognize no official leaders. Camps are traditionally named after a senior male (hence,

Michael Finkel reported on Islam in Indonesia for our October issue. Award-winning photographer Martin Schoeller is best known for his close-up portraits.

Onwas's camp), but this honor does not confer any particular power. Individual autonomy is the hallmark of the Hadza. No Hadza adult has authority over any other. None has more wealth; or, rather, they all have no wealth. There are few social obligations—no birthdays, no religious holidays, no anniversaries.

People sleep whenever they want. Some stay up much of the night and doze during the heat of the day. Dawn and dusk are the prime hunting times; otherwise, the men often hang out in camp, straightening arrow shafts, whittling bows, making bowstrings out of the ligaments of giraffes or impalas, hammering nails into arrowheads. They trade honey for the nails and for colorful plastic and glass beads that the women fashion into necklaces. If a man receives one as a gift, it's a good sign he has a female admirer.

There are no wedding ceremonies. A couple that sleeps at the same fire for a while may eventually refer to themselves as married. Most of the Hadza I met, men and women alike, were serial monogamists, changing spouses every few years. Onwas is an exception; he and his wife, Mille, have been with each other all their adult lives, and they have seven living children and several grandchildren. There was a bevy of children in the camp, with the resident grandmother, a tiny, cheerful lady named Nsalu, running a sort of day care while the adults were in the bush. Except for breast-feeding infants, it was hard to determine which kids belonged to which parents.

Gender roles are distinct, but for women there is none of the forced subservience knit into many other cultures. A significant number of Hadza women who marry out of the group soon return, unwilling to accept bullying treatment. Among the Hadza, women are frequently the ones who initiate a breakup—woe to the man who proves himself an incompetent hunter or treats his wife poorly. In Onwas's camp, some of the loudest, brashest members were women.

One in particular, Nduku, appointed herself my language teacher and spent a good percentage of every lesson teasing me mercilessly, often rolling around in laughter as I failed miserably at reproducing the distinct, tongue-tricky clicks.

Onwas knows of about 20 Hadza groups roaming the bush in his area, constantly swapping members, like a giant square dance. Most conflicts are resolved by the feuding parties simply separating into different camps. If a hunter brings home a kill, it is shared by everyone in his camp. This is why the camp size is usually no more than 30 people—that's the largest number who can share a good-size game animal or two and feel decently sated.

I was there during the six-month dry season, May through October, when the Hadza sleep in the open, wrapped in a thin blanket beside a campfire—two to six people at each hearth, eight or nine fires spread in a wide semicircle fronting a brush-swept common area. The sleep groupings were various: families, single men, young women (with an older woman as minder), couples. During the rainy season, they construct little domed shelters made of interwoven twigs and long grasses: basically, upside-down bird's nests. To build one takes no more than an hour. They move camp roughly once a month, when the berries run low or the hunting becomes tough or there's a severe sickness or death.

No one sleeps alone in Onwas's camp. He assigned his son Ngaola, the one who had waited a few days by the tree, to stay with me, and Ngaola recruited his friend Maduru to join us. The three of us slept in a triangle, head to toe to head around our fire, though when the mosquitoes were fierce, I slept in my tent.

Ngaola is quiet and introspective and a really poor hunter. He's about 30 years old and still unmarried; bedeviled, perhaps, by the five-baboon rule. It pains him that his older brother, Giga, is probably the most skilled archer in

Hadza women such as Samay are independent and powerful, free to marry or divorce at will. Scars on her cheeks may be from childhood cuts meant to curb crying—tears make cuts sting.

Following pages: As Ncolo (left) and his sister Sangu grow up, they will shoulder more adult duties.









camp. Maduru is a solid outdoorsman, an especially good honey finder, but something of a Hadza misfit. When a natural snakebite remedy was passed around camp, Maduru was left out of the distribution. This upset him greatly, and Onwas had to spend an hour beside him, an arm slung avuncularly over his shoulder, calming him down.

Maduru is the one who assumes responsibility for me during the nighttime baboon quest. As we move through the bush, he snaps off eye-level acacia branches with thorns the size of toothpicks and repeatedly checks to make sure I'm keeping pace. Onwas leads us to the hill where he'd seen the tree full of baboons.

Here we stop. There are hand signals, some clipped chatter. I'm unsure of what is going on—my translator has remained back at camp. The hunt is only for men. But Maduru taps me on the shoulder and motions for me to follow. The other hunters begin fanning out around the base of the hill, and I tail Maduru as he plunges into the brush and starts to climb. The slope seems practically vertical—hands are required to haul yourself up—and the thickets are as dense as Brillo pads. Thorns slice into my hands, my face. A trickle of blood oozes into my eye. We climb. I follow Maduru closely; I do not want to become separated.

Finally, I understand. We are climbing up, from all sides, toward the baboons. We are trying to startle them, to make them run. From the baboons' perch atop the hill, there is no place to go but down. The Hadza have encircled the hill; therefore, the baboons will be running toward the hunters. Possibly toward Maduru and me.

Have you ever seen a baboon up close? They have teeth designed for ripping flesh. An adult male can weigh more than 80 pounds. And here we are, marching upward, purposely trying to

provoke them. The Hadza are armed with bows and arrows. I have a pocketknife.

We move higher. Maduru and I break out of the undergrowth and onto the rocks. I feel as though I've emerged from beneath a blanket. There is a sickle of moon, a breeze. We are near the summit—the top is just over a stack of boulders, maybe 20 feet above our head. The baboon tree is up there, barely out of eyesight.

Then I hear it—a crazed screeching sound. The baboons are aware that something is amiss. The sound is piercing, panicked. I do not speak baboon, but it is not difficult to interpret. *Go away! Do not come closer!* But Maduru clambers farther, up onto a flat rock. I follow. The baboons are surrounded, and they seem to sense it.

Abruptly, there's a new sound. The crack of branches snapping overhead. The baboons are descending, shrieking. Maduru freezes, drops to one knee, slides an arrow into position, pulls back the bowstring. He is ready. I'm hiding behind him. I hope, I fervently hope, that no baboons run at us. I reach into my pocket, pull out my knife, unfold it. The blade is maybe two inches long. It feels ridiculous, but that is what I do.

The screeching intensifies. And then, directly over us, in stark silhouette against the backdrop of stars, is a baboon. Scrambling. Moving along the rock's lip. Maduru stands, takes aim, tracking the baboon from left to right, the arrow slotted, the bowstring at maximum stretch. Every muscle in my body tenses. My head pulses with panic. I grip my knife.

The chief reason the Hadza have been able to maintain their lifestyle so long is that their homeland has never been an inviting place. The soil is briny; fresh water is scarce; the bugs can be intolerable. For tens of thousands of years, it seems, no one else wanted to live here. So the Hadza were left alone. Recently, however, escalating population pressures have brought a

A rugged life in the bush shows on the face of Moko, a skilled hunter. The striking genet-tail headdress could be a flourish to impress outsiders, or it may be a local fad—Hadza aren't immune to fashion.

flood of people into Hadza lands. The fact that the Hadza are such gentle stewards of the land has, in a way, hurt them—the region has generally been viewed by outsiders as empty and unused, a place sorely in need of development. The Hadza, who by nature are not a combative people, have almost always moved away rather than fight. But now there is nowhere to retreat.

There are currently cattle herders in the Hadza bush, and goat herders, and onion farmers, and corn growers, and sport hunters, and game poachers. Water holes are fouled by cow excrement. Vegetation is trampled beneath cattle's hooves. Brush is cleared to make way for crops; scarce water is used to irrigate them. Game animals have migrated to national parks, where the Hadza can't follow. Berry groves and trees that attract bees have been destroyed. Over the past century, the Hadza have lost exclusive possession of as much as 90 percent of their homeland.

None of the other ethnic groups living in the area—the Datoga, the Iraqw, the Isanzu, the Sukuma, the Iramba—are hunter-gatherers. They live in mud huts, often surrounded by livestock enclosures. Many of them look down on the Hadza and view them with a mix of pity and disgust: the untouchables of Tanzania. I once watched as a Datoga tribesman prevented several Hadza women from approaching a communal water hole until his cows had finished drinking.

Dirt roads are now carved into the edges of the Hadza bush. A paved road is within a four-day walk. From many high points there is decent cell phone reception. Most Hadza, including Onwas, have learned to speak some Swahili, in order to communicate with other groups. I was asked by a few of the younger Hadza hunters if I could give them a gun, to make it easier to harvest game. Onwas himself, though he's scarcely ventured beyond the periphery of the bush, senses that profound changes are coming. This does not appear to bother him. Onwas, as he repeatedly told me, doesn't worry about the future. He doesn't worry about anything. No Hadza I met, in fact, seemed prone to worry. It was a mind-set that astounded me, for the Hadza, to my way of thinking, have very

legitimate worries. *Will I eat tomorrow? Will something eat me tomorrow?* Yet they live a remarkably present-tense existence.

This may be one reason farming has never appealed to the Hadza—growing crops requires planning; seeds are sown now for plants that won't be edible for months. Domestic animals must be fed and protected long before they're ready to butcher. To a Hadza, this makes no sense. Why grow food or rear animals when it's being done for you, naturally, in the bush? When they want berries, they walk to a berry shrub. When they desire baobab fruit, they visit a baobab tree. Honey waits for them in wild hives. And they keep their meat in the biggest storehouse in the world—their land. All that's required is a bit of stalking and a well-shot arrow.

There are other people, however, who do ponder the Hadza's future. Officials in the Tanzanian government, for starters. Tanzania is a future-oriented nation, anxious to merge into the slipstream of the global economy. Baboon-hunting bushmen is not an image many of the country's leaders wish to project. One minister has referred to the Hadza as backward. Tanzania's president, Jakaya Kikwete, has said that the Hadza "have to be transformed." The government wants them schooled and housed and set to work at proper jobs.

Even the one Hadza who has become the group's de facto spokesperson, a man named Richard Baalow, generally agrees with the government's aims. Baalow, who adopted a non-Hadza first name, was one of the first Hadza to attend school. In the 1960s his family lived in government-built housing—an attempt at settling the Hadza that soon failed. Baalow, 53, speaks excellent English. He wants the Hadza to become politically active, to fight for legal protection of their land, and to seek jobs as hunting guides or park rangers. He encourages Hadza children to attend the regional primary school that provides room and board to Hadza students during the academic year, then escorts them back to the bush when school is out.

The school-age kids I spoke with in Onwas's group all said they had no interest in sitting in

**EVER SEEN A BABOON
UP CLOSE? THEIR TEETH ARE
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I HAVE A POCKETKNIFE.**

a classroom. If they went to school, many told me, they'd never master the skills needed for survival. They'd be outcasts among their own people. And if they tried their luck in the modern world—what then? The women, perhaps, could become maids; the men, menial laborers. It's far better, they said, to be free and fed in the bush than destitute and hungry in the city.

More Hadza have moved to the traditionally Hadza area of Mangola, at the edge of the bush, where, in exchange for money, they demonstrate their hunting skills to tourists. These Hadza have proved that their culture is of significant interest to outsiders and a potential source of income. Yet among the Hadza of Mangola there has also been a surge in alcoholism, an outbreak of tuberculosis, and a distressing rise in domestic violence, including at least one report of a Hadza man who beat his wife to death.

Though the youngsters in Onwas's group show little interest in the outside world, the world is coming to them. After two million years, the age of the hunter-gatherer is over. The Hadza may hold on to their language; they may demonstrate their abilities to tourists. But it's only a matter of time before there are no more traditional Hadza scrambling in the hills with their bows and arrows, stalking baboons.

Up on the hill Onwas has led us to, clutching my knife, I crouch behind Maduru as the baboon moves along a fin of rock. And then, abruptly, the baboon stops. He swivels his head. He is so close we could reach out to each other and make contact. I stare into his eyes, too frightened to even blink. This lasts maybe a second. Maduru doesn't shoot, possibly because the animal is too close and could attack us if wounded—it's often the poison, not the arrow, that kills. An instant later the baboon leaps away into the bushes.

There is silence for a couple of heartbeats. Then I hear frantic yelping and crashing. It's coming from the far side of the rock, and I can't tell if it is human or baboon. It's both. We thrash through bushes, half-tumbling, half-running,

until we reach a clearing amid a copse of acacias.

And there it is: the baboon. On his back, mouth open, limbs splayed. Shot by Giga. A nudge with a toe confirms it—dead. Maduru whistles and shouts, and soon the other hunters arrive. Onwas kneels and pulls the arrow out of the baboon's shoulder and hands it back to Giga. The men stand around the baboon in a circle, examining the kill. There is no ceremony. The Hadza are not big on ritual. There is not much room in their lives, it seems, for mysticism, for spirits, for pondering the unknown. There is no specific belief in an afterlife—every Hadza I spoke with said he had no idea what might happen after he died. There are no Hadza priests or shamans or medicine men. Missionaries have produced few converts. I once asked Onwas to tell me about God, and he said that God was blindingly bright, extremely powerful, and essential for all life. God, he told me, was the sun.

The most important Hadza ritual is the *epeme* dance, which takes place on moonless nights. Men and women divide into separate groups. The women sing while the men, one at a time, don a feathered headdress and tie bells around their ankles and strut about, stomping their right foot in time with the singing. Supposedly, on *epeme* nights, ancestors emerge from the bush and join the dancing. One night when I watched the *epeme*, I spotted a teenage boy, Mataiyo, sneak into the bush with a young woman. Other men fell asleep after their turn dancing. Like almost every aspect of Hadza life, the ceremony was informal, with a strictly individual choice of how deeply to participate.



A hunting party tracks a warthog that's been shot, scouting the blood trail using skills passed down through generations. Here, near the edge of the Serengeti Plain, Hadza hunters also take bigger game such as giraffe. The successful bowman, Garach (at right), will share much of the warthog meat.



With the Hadza god not due to rise for several hours, Giga grabs the baboon by a rear paw and drags the animal through the bush back to camp. The baboon is deposited by Onwas's fire, while Giga sits quietly aside with the other men. It is Hadza custom that the hunter who's made the kill does not show off. There is a good deal of luck in hunting, and even the best archers will occasionally face a long dry spell. This is why the Hadza share their meat communally.

Onwas's wife, Mille, is the first to wake. She's wearing her only set of clothes, a sleeveless T-shirt and a flower-patterned cloth wrapped about her like a toga. She sees the baboon, and with the merest sign of pleasure, a brief nod of her chin, she stokes the fire. It's time to cook. The rest of camp is soon awake—everyone is hungry—and Ngaola skins the baboon and stakes out the pelt with sharpened twigs. The skin will be dry in a few days and will make a fine sleeping mat. A couple of men butcher the animal, and cuts of meat are distributed. Onwas, as camp elder, is handed the greatest delicacy: the head.

The Hadza cooking style is simple—the meat is placed directly on the fire. No grill, no pan. Hadza mealtime is not an occasion for politeness. Personal space is generally not recognized; no matter how packed it is around a fire, there's always room for one more, even if you end up on someone's lap. Once a cut of meat has finished cooking, anyone can grab a bite.

And I mean grab. When the meat is ready, knives are unsheathed and the frenzy begins. There is grasping and slicing and chewing and pulling. The idea is to tug at a hunk of meat with your teeth, then use your knife to slice away your share. Elbowing and shoving is standard behavior. Bones are smashed with rocks and the marrow sucked out. Grease is rubbed on the skin as a sort of moisturizer. No one speaks a word, but the smacking of lips and gnashing of teeth is almost comically loud.

I'm ravenous, so I dive into the scrum and snatch up some meat. Baboon steak, I have to say, isn't terrible—a touch gamy, but it's been a few days since I've eaten protein, and I can feel my body perking up with every bite. Pure

**I ENVY HOW FREE
THE HADZA APPEAR TO BE.
FREE FROM POSSESSIONS AND
MOST SOCIAL DUTIES.
FREE FROM SCHEDULES, JOBS,
BOSSES, LAWS, NEWS, MONEY.
FREE FROM WORRY.**

fat, rather than meat, is what the Hadza crave, though most coveted are the baboon's paw pads. I snag a bit of one and pop it in my mouth, but it's like trying to swallow a pencil eraser. When I spit the gob of paw pad out, a young boy instantly picks it up and swallows it.

Onwas, with the baboon's head, is comfortably above the fray. He sits cross-legged at his fire and eats the cheeks, the eyeballs, the neck meat, and the forehead skin, using the soles of his sandals as a cutting board. He gnaws the skull clean to the bone, then plunges it into the fire and calls me and the hunters over for a smoke.

It is impossible to overstate just how much Onwas—and most Hadza—love to smoke. The four possessions every Hadza man owns are a bow, some arrows, a knife, and a pipe, made from a hollowed-out, soft stone. The smoking material, tobacco or cannabis, is acquired from a neighboring group, usually the Datoga, in exchange for honey. Onwas has a small amount of tobacco, which is tied into a ball inside his shirttail. He retrieves it, stuffs it all into his pipe, and then, holding the pipe vertically, plucks an ember from the fire and places it atop his pipe. Pulsing his cheeks in and out like a bellows, he inhales the greatest quantity of smoke he possibly can. He passes the pipe to Giga.

Then the fun begins. Onwas starts to cough,

slowly at first, then rapidly, then uncontrollably with tears bursting from his eyes, then with palms pushing against his head, and then, finally, rolling onto his back, spitting and gasping for air. In the meantime, Giga has begun a similar hacking session and has passed the pipe to Maduru, who then passes the pipe to me. Soon, all of us, the whole circle of men, are hacking and crying and rolling on our backs. The smoke session ends when the last man sits up, grinning, and brushes the dirt from his hair.

With the baboon skull still in the fire, Onwas rises to his feet and claps his hands and begins to speak. It's a giraffe-hunting story—Onwas's favorite kind. I know this even though Mariamu, my translator, is not next to me. I know because Onwas, like many Hadza, is a story performer. There are no televisions or board games or books in Onwas's camp. But there is entertainment. The women sing songs. And the men tell campfire stories, the Kabuki of the bush.

Onwas elongates his neck and moves around on all fours when he's playing the part of the giraffe. He jumps and ducks and pantomimes shooting a bow when he's illustrating his own role. Arrows whoosh. Beasts roar. Children run to the fire and stand around, listening intently; this is their schooling. The story ends with a dead giraffe—and as a finale, a call and response.

"Am I a man?" asks Onwas, holding out his hands.

"Yes!" shouts the group. "You are a man."

"Am I a man?" asks Onwas again, louder.

"Yes!" shouts the group, their voices also louder. "You are a man!"

Onwas then reaches into the fire and pulls out the skull. He hacks it open, like a coconut, exposing the brains, which have been boiling for a good hour inside the skull. They look like ramen noodles, yellowish white, lightly steaming. He holds the skull out, and the men,

Baboon hunters (top right) team up to haul quarry back to camp at sunrise. Arrows tipped with poison from desert rose plants help bring down prey. Tissue near wounds is excised so diners don't ingest the toxin. The arrival of meat in camp may spur a line dance (bottom right), but the Hadza also dance deep in the night as a ritual or at any hour for sheer pleasure.



including myself, surge forward and stick our fingers inside the skull and scoop up a handful of brains and slurp them down. With this, the night, at last, comes to an end.

The baboon hunt, it seems, was something of an initiation for me. The next day, Nyudu hacks down a thick branch from a *mutateko* tree, then carefully carves a bow for me, long and gracefully curved. Several other men make me arrows. Onwas presents me with a pipe. Nkulu handles my shooting lessons. I begin to carry my bow and arrows and pipe with me wherever I go (along with my water-purification kit, my sunscreen, my bug spray, and my eyeglass-cleaning cloth).

I am also invited to bathe with the men. We walk to a shallow, muddy hole—more of a large puddle, with lumps of cow manure bobbing about—and remove our clothes. Handfuls of mud are rubbed against the skin as an exfoliant, and we splash ourselves clean. While Hadza have a word for body odor, the men tell me that they prefer their women not to bathe—the longer they go between baths, they say, the more attractive they are. Nduku, my Hadza language teacher, said she sometimes waits months between baths, though she can't understand why her husband wants her that way. I also discover, by listening to Mille and Onwas, that bickering with one's spouse is probably a universal human trait. "Isn't it your turn to fetch water?" "Why are you napping instead of hunting?" "Can you explain why the last animal brought to camp was skinned so poorly?" It occurs to me that these same arguments, in this same valley, have been taking place for thousands of years.

There are things I envy about the Hadza—mostly, how free they appear to be. Free from possessions. Free of most social duties. Free from religious strictures. Free of many family responsibilities. Free from schedules, jobs, bosses,

bills, traffic, taxes, laws, news, and money. Free from worry. Free to burp and fart without apology, to grab food and smoke and run shirtless through the thorns.

But I could never live like the Hadza. Their entire life, it appears to me, is one insanely committed camping trip. It's incredibly risky. Medical help is far away. One bad fall from a tree, one bite from a black mamba snake, one lunge from a lion, and you're dead. Women give birth in the bush, squatting. About a fifth of all babies die within their first year, and nearly half of all children do not make it to age 15. They have to cope with extreme heat and frequent thirst and swarming tsetse flies and malaria-laced mosquitoes.

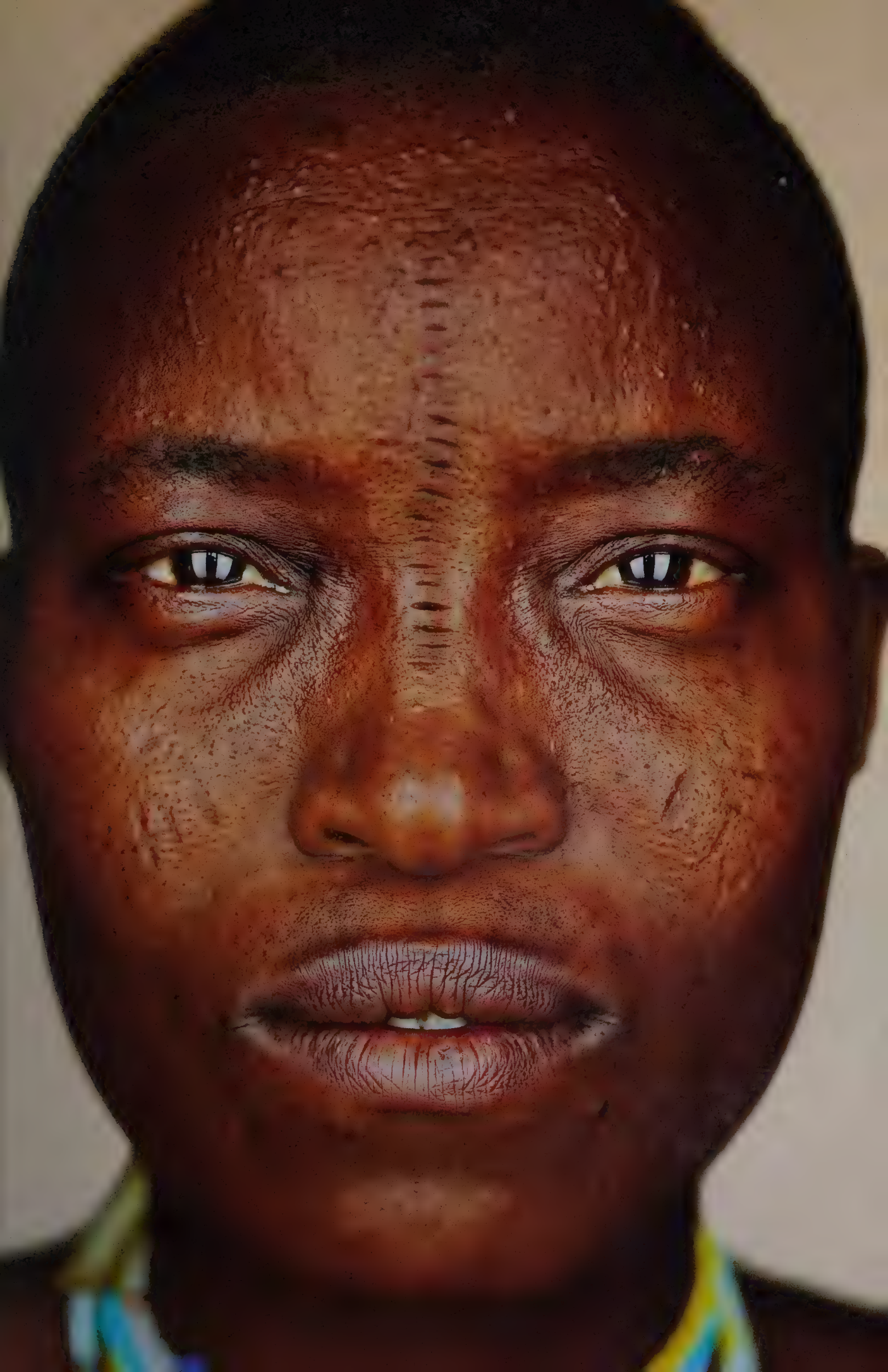
The days I spent with the Hadza altered my perception of the world. They instilled in me something I call the "Hadza effect"—they made me feel calmer, more attuned to the moment, more self-sufficient, a little braver, and in less of a constant rush. I don't care if this sounds maudlin: My time with the Hadza made me happier. It made me wish there was some way to prolong the reign of the hunter-gatherers, though I know it's almost certainly too late.

It was my body, more than anything, that let me know it was time to leave the bush. I was bitten and bruised and sunburned and stomach-achy and exhausted. So, after two weeks, I told everyone in camp I had to go.

There was little reaction. The Hadza are not sentimental like that. They don't do extended goodbyes. Even when one of their own dies, there is not a lot of fuss. They dig a hole and place the body inside. A generation ago, they didn't even do that—they simply left a body out on the ground to be eaten by hyenas. There is still no Hadza grave marker. There is no funeral. There's no service at all, of any sort. This could be a person they had lived with their entire life. Yet they just toss a few dry twigs on top of the grave. And they walk away. □

Holo, Onwas's daughter, will raise her own five children in intimate touch with the land that supports them.

Curiously indifferent to most vestiges of modernity, the Hadza continue to survive on their own terms.



LOVE

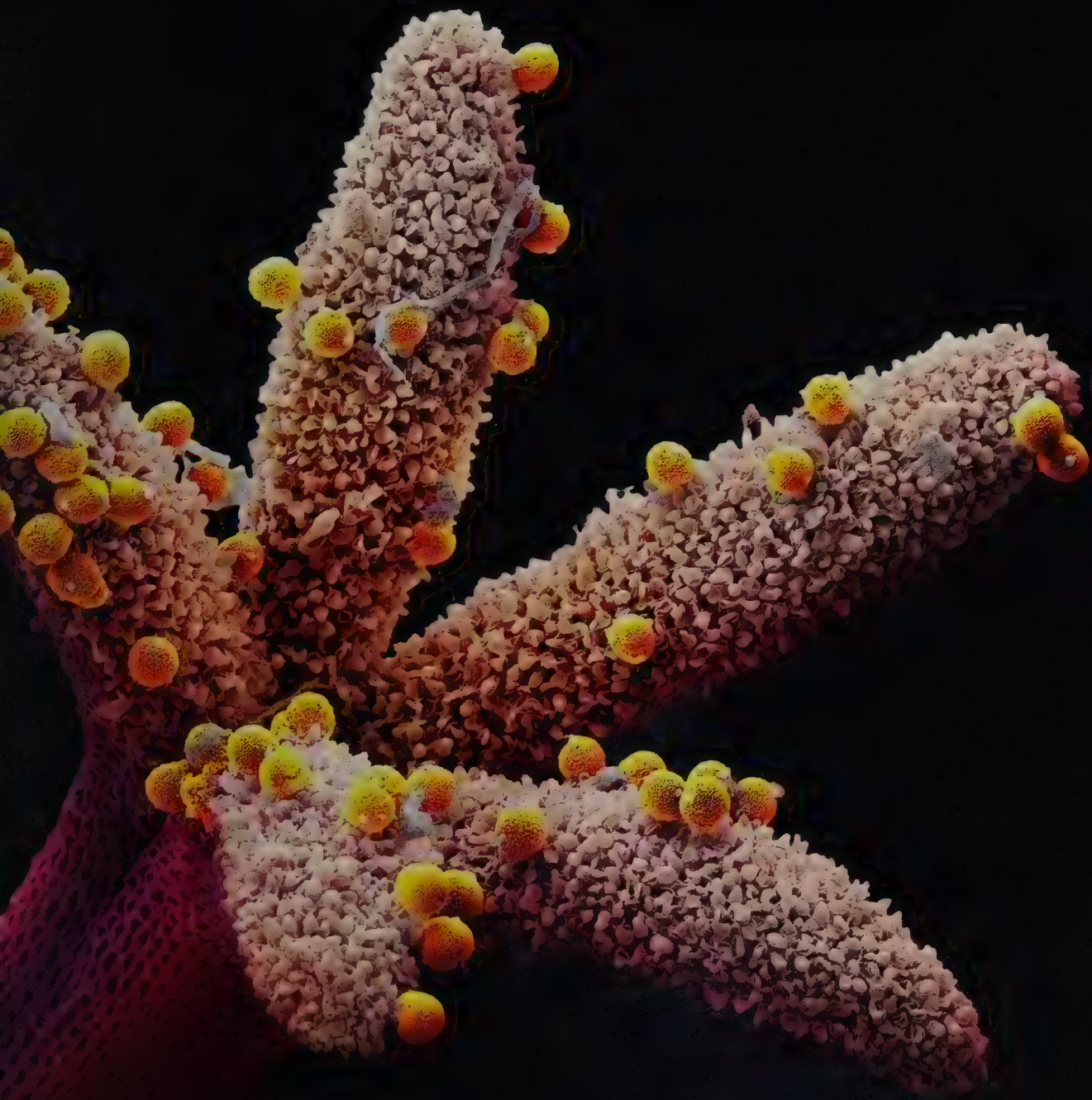
IS

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Birds do it, bees do it, even pollinating plants do it.

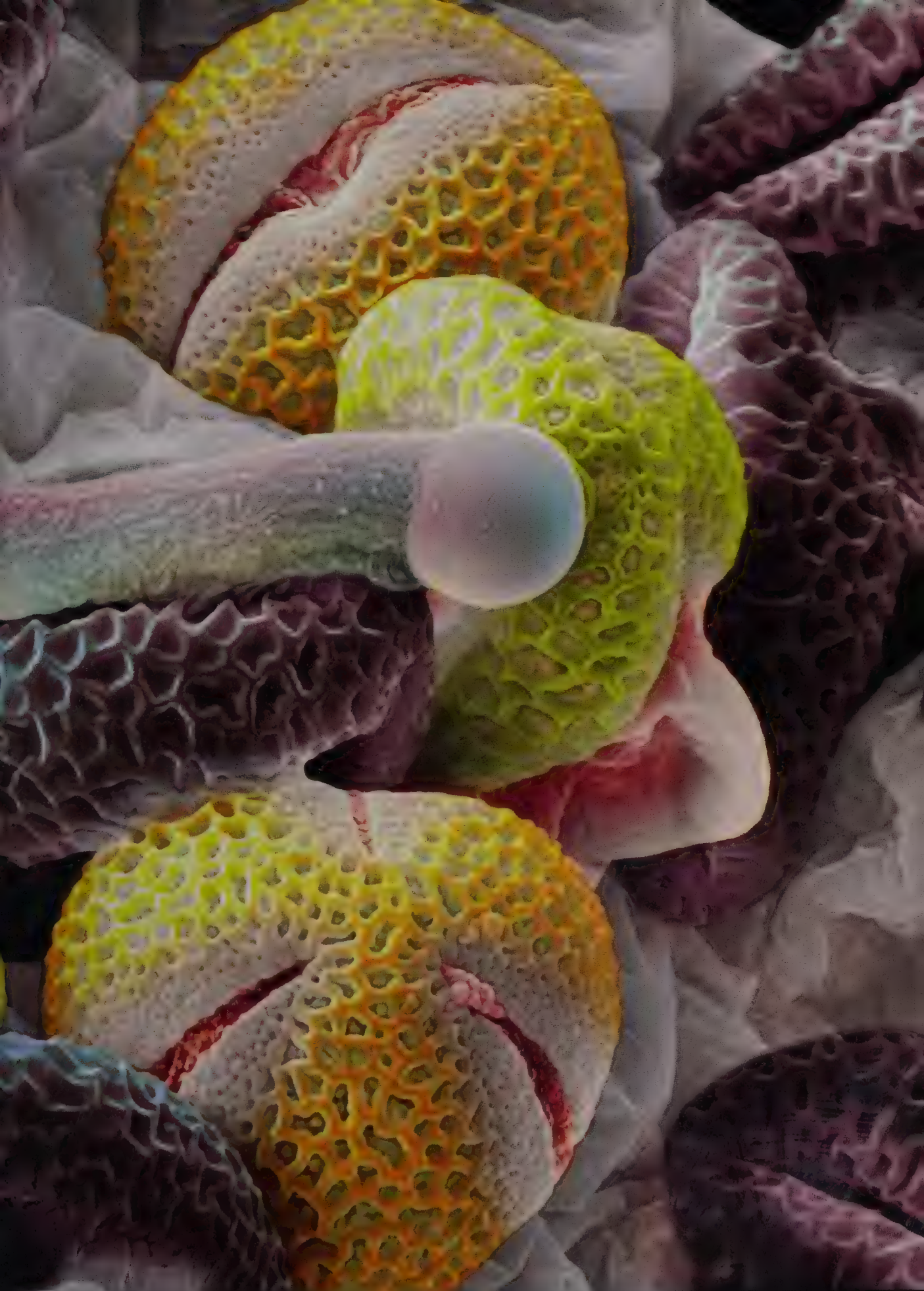


Geranium

The size of the grains is measured in millionths of a meter, but the romantic journeys of pollen are epic. The dozens of golden grains that have successfully reached a *Geranium phaeum* flower's stigma must compete to be among the few that achieve fertilization.



Snowball blossom



Lodged in the rumpled tissue of a *Viburnum tinus* stigma, pollen grains from other snowball blossoms (gray) swell with moisture. One (at center) is already growing the tube that delivers sperm to the ovule. Other species' pollen (yellow and green) has landed amiss; genetic defenses exclude them from the fertilization race.

By Rob Dunn

Photographs by Martin Oeggerli



s humans we take many things for granted. One is surely the ability to walk, crawl, or even, after a little too much to drink, drag ourselves over to a lovely member of the opposite sex. Plants have no such luxury. For much of the long history of green

life on land, plants had to be near each other, touching almost, to mate. Moss lets its pale sperm into rainwater to float to nearby partners, as did other early plants, but this method requires moisture. Vegetation could only survive in those damp corners where beads of water connected, dependably, a male to a female. Most of the Earth was brown.

Then one day more than 375 million years ago, it happened. One lineage of plants evolved pollen grains and seeds, and from then on nothing was the same. Let's not mince words. Pollen is plant sperm—two individuals per grain—surrounded by a single, often golden, wall that offers both protection and chariot. If the tension in the long story of plants was the distance between lovers, pollen was what would bring them together, over feet or even across continents. It was an evolutionary trick that transformed the world by letting strangers have sex.

Life remained a long shot. Pollen lunged into gusts of wind on the chance that a few grains would find their mark. With time came more contrivances. Pollen sacks burst, propelling the grains. Pollen evolved balloon-like wings to catch the breeze. Plants began to produce thousands, millions, billions of individual grains. They made many that one might succeed.

The target that each of those billions of pollen grains aims for is the naked ovule (the future seed) of another plant of the same species. At the ovule, which contains an egg cell, the pollen grain attempts to initiate a tube to connect sperm and egg. If the pollen lands on the wrong species of plant or is too weak or old, the tube does not form. But every so often it does, and then one of the two sperm, the chosen one, travels to fertilization, and a viable seed develops. That there are plants at all is testament to the more than occasional success of this intimate, improbable lottery.

Life proceeded like this, with pollen carried by wind and chance to ovules, for millions of years, until things changed again—"a soundless, violent explosion," the naturalist Loren Eiseley called it. In one lineage, individuals evolved seeds protected in fruits and surrounded by petals. That lineage, the angiosperms, did better because their ovules were protected (in ovaries, which turn into fruit), and because the petals attracted animals that, however accidentally,

The images in this story were made with a scanning electron microscope, which uses beams of electrons to trace the surfaces of objects. The resulting 3-D images, originally black-and-white, were enhanced with color.



Willow A grain of *Salix caprea* pollen has missed its mark. Wedged between flower petals, it will die. While some grains will be flung into the air as springtime breezes swirl the willow leaves, others will stick to the backs of bees and find their way.

Pollen, and ultimately flowers, led to explosive diversification in plants, turning a brown planet green and then red, yellow, white, orange, and all the rest.

carried pollen on feathers, skin, or hair. Animals carried pollen from flower to flower more consistently than did wind, so plants with attractive petals were favored. Flowers evolved many colors to woo and nectar, an additional lure. Animals came in the thousands. Hummingbirds and honeycreepers evolved long beaks to reach nectar. Moths, bees, and flies evolved long, sucking mouthparts. Bats evolved long, sticky tongues—some of them nearly twice as long as their bodies.

The nectar-gathering animals disperse pollen at the same time. Foraging bumblebees collect pollen on tiny hairs while they bump around in



Pollen comes in many forms and sizes. The diameter of a pumpkin pollen grain (at center) is as thick as a dollar bill. The tiny speck at its lower right is a grain of forget-me-not pollen.

flowers drinking, and deposit that pollen at the same time as they buzz among flowers. Then they go one further by scraping some collected pollen into tiny baskets, corbiculae, on their rear legs. Once home, the bees store the pollen in pots they make out of wax, keeping it to eat on rainy days.

In allowing plants to have sex at a distance, pollen, and ultimately flowers, led to explosive diversification, turning a brown planet green and then red, yellow, white, orange, and all the rest. Pollen diversified too. In the 300,000 pollen-bearing plant species on Earth, there are 300,000 different forms of pollen. The great variety in colors, shapes, and textures of the grains has evolved in accordance with each plant's biological particulars. Beetle-pollinated plants tend to have smooth, sticky pollen, the better to adhere to the lumbering beetles' backs. Plants pollinated by fast-moving bees or flies may have spiny pollen that lodges easily between the insects' hairs. Plants pollinated by bigger animals, such as bats, sometimes have bigger pollen, though not always—perhaps not even most of the time. In the details of pollen's variety, more remains to be explained than is understood.

The most recent story in the history of pollen is recorded not by the successes but by the failures. The air, however clear, is full of unsuccessful pollen, drifting in eddies of wind. Billions of grains reach the stratosphere. Even now, as you read, a few grains may rest on your hands or face, or on your cat. Pollen settles and accumulates in sediment, layer after layer, particularly at the bottoms of lakes and ponds.

In those layers, where decay is slow, pollen constitutes a history book far outlasting the plants that produce it. Grass pollen in sediment means grasslands, pine pollen indicates pine forests, and so on—an encyclopedia of detail spelled out in the mud. Palynologists take core samples of lake-bottom layers to examine shifts in the species of plants from one layer to the next. Collectively such chronicles of changing plant life can span thousands of years or more.

Scientists studying the pollen in core samples

see changes in the frequency of fires, the retreat and expansion of species with glaciations, and more. But the biggest change in millennia has come recently, a measure of the march of human technologies. With the spread of agriculture, tree pollen has, spring after spring, grown less common and the pollen of cereals and weeds more so. As we change Earth's climate, species long adapted to the cold will become rarer, and the pollen of new arrivals from warmer regions will increase. As we fly around the world, the pollen of Asian species is turning up in North America, of African species in Hawaii, of Australian species in South Africa.

Pollen has tracked the progress of civilizations before. In the Maya lowlands of Guatemala, the pollen of forest trees was once the most common. Around 4,600 years ago, corn pollen started to appear. By 2,000 years ago, most pollen came from plants associated with agriculture.

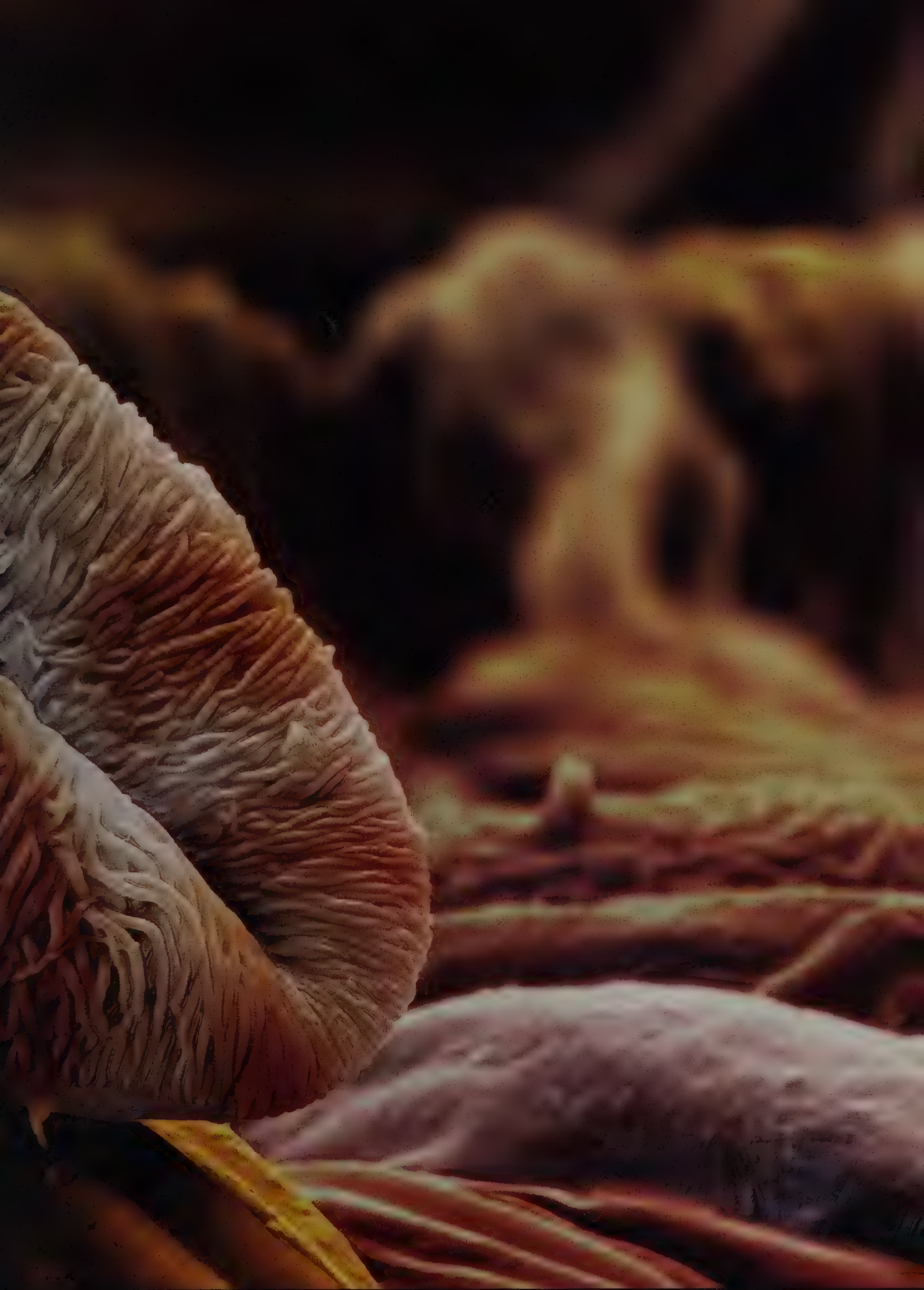
Then around a thousand years ago, corn pollen began to disappear. Weed pollen too. Eventually, the pollen of trees came back. In seeing this change, palynologists can infer much of the rest. The birds also came back, as did the bees and even the bats with their long, sticky tongues. Like all records, the record of pollen has biases, but here the big message needs little interpretation. The civilization rose and then faded—the temples giving way to the scramble of roots and the rise of trees with their pendulant flowers and abundant pollen, which was cast once more into the air and onto animals' wiggling backs. Whatever happens to us in the years to come, the pollen will continue to record. It offers no criticism, just testament.

All life, including our own, is improbable, but somehow the lives of plants, dependent on pollen's traffic, are particularly so. And yet they find each other again and again, as they have since before the days of the dinosaurs, when giant dragonflies cruised the air, yellow dust no doubt stuck in their prehistoric hair. □

Ecologist Rob Dunn, author of Every Living Thing, is a professor at North Carolina State University. Martin Oeggerli is a Swiss molecular biologist.



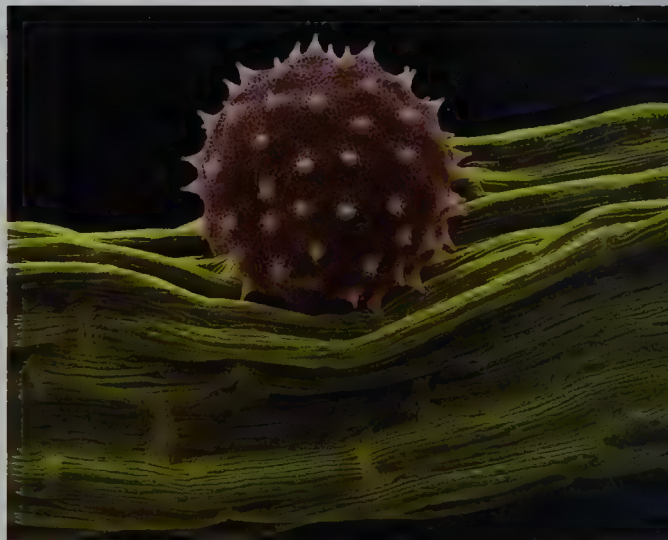
Flowering quince



The convoluted surface of *Chaenomeles* sp. pollen may speed up moisture absorption when the grain lands on a target bloom. "Quick hydration means faster formation of the pollen tube," says Swiss photographer Martin Oeggerli, a postdoctoral fellow at University Hospital Basel. "That's important for fertilization."



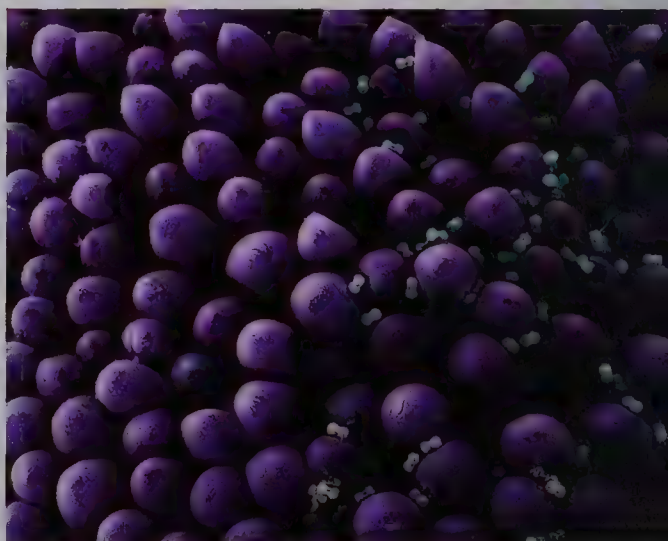
White clover *TRIFOLIUM REPENS*



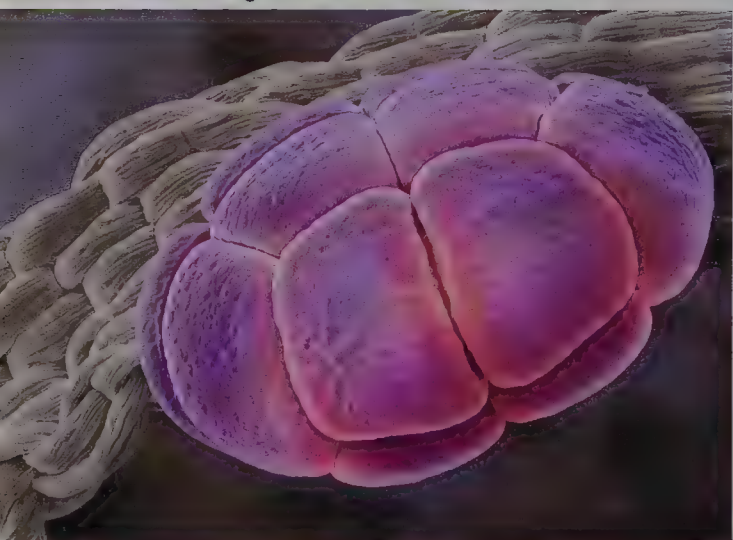
Indian mallow *ABUTILON PICTUM*



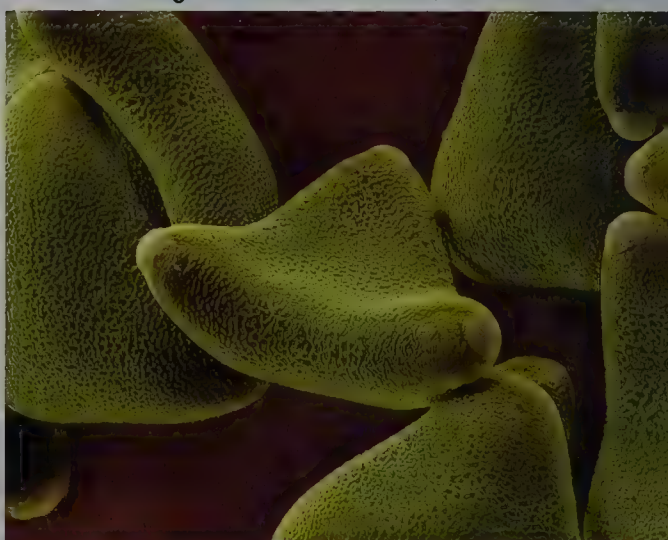
Water cabbage *PISTIA STRATIOTES*



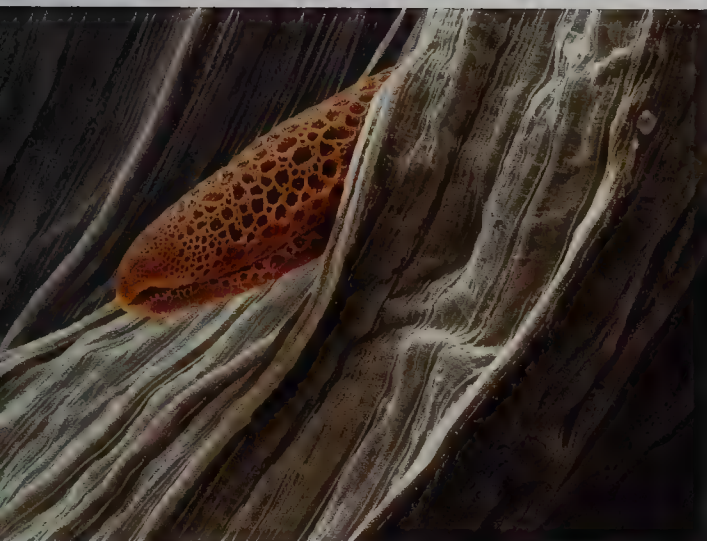
Forget-me-not *MYOSOTIS SYLVATICA*



Persian silk tree *ALBIZIA JULIBRISSIN*



Silver leaf tree *PROTEACEAE*



Bromeliad *TILLANDSIA MAXIMA*



Venus flytrap *DIONAEA MUSCIPULA*



Poison bulb *CRINUM JAPONICUM*

FORM AND FUNCTION

Primordial plant pollen resembled small, smooth planets buffeted in a gusty universe. Over time, evolution has produced a panoply of pollen grains. White clover's protein-rich pollen (top left) is an important food for bees, as is its nectar. Spines on Indian mallow pollen (top middle) help it cling to bird feathers. The fold in a bromeliad grain (top right) allows it to shrink as it dries, or swell with moisture, without breaking. The ridges on water cabbage grains (center left) are an unusual pollen surface feature, though the plant is common from Egypt to Argentina. Forget-me-not grains (center middle, colored turquoise) are among the tiniest known, each just five one-thousandths of a millimeter across. Venus flytrap (center right) and Persian silk tree (bottom left) grains are more than 15 times bigger: There's no consistent correlation between plant and pollen size. Silver leaf tree grains (bottom middle) have a sticky coating that bonds them to animal carriers. Poison-bulb pollen (bottom right) is surrounded by long, showy petals that attract insect porters. Some variations seem easy to explain. Others remain puzzling, or have yet to be investigated at all.



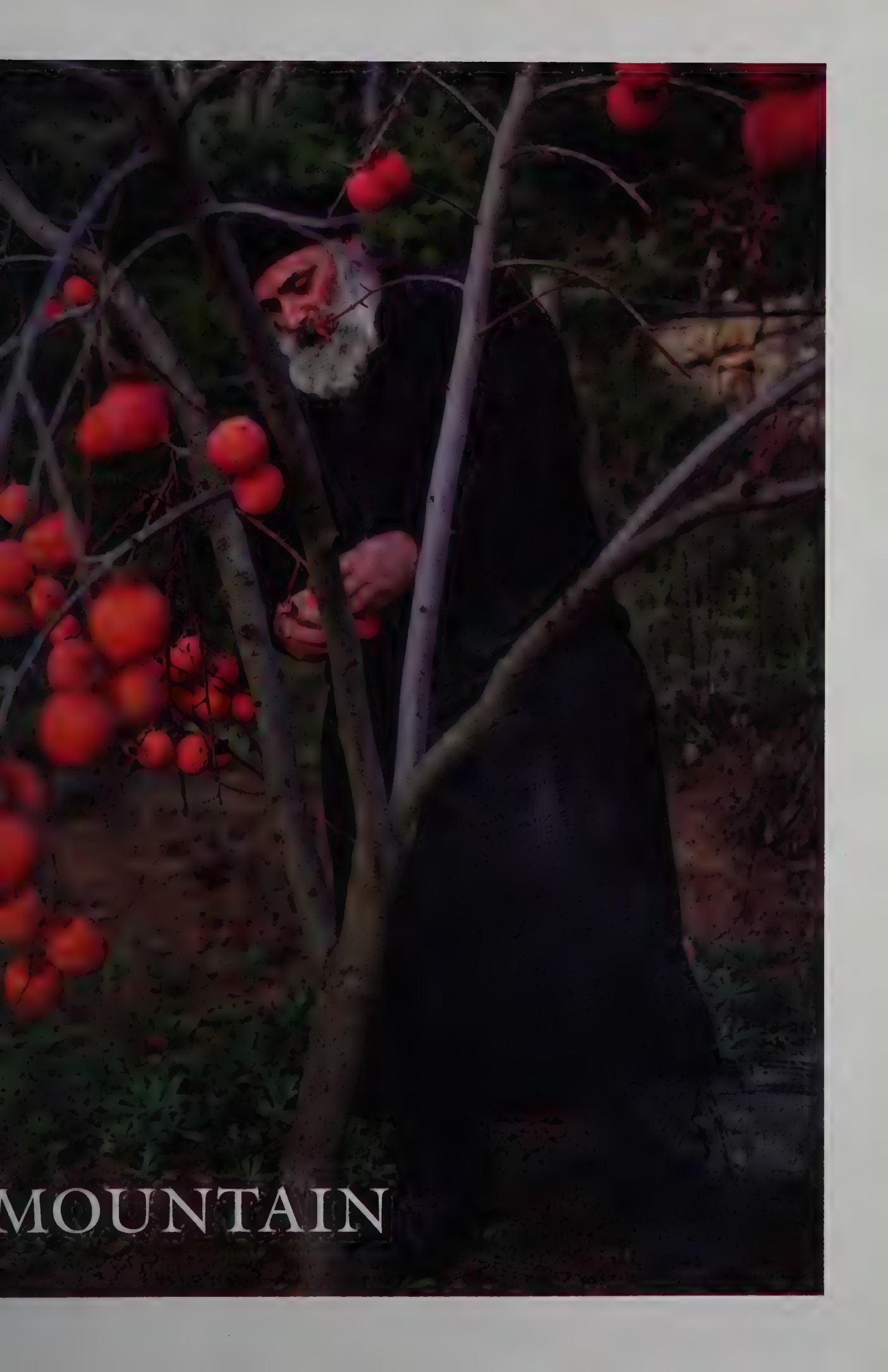


The pollen of this family coats cars with yellow-green dust—though this particular grain landed on an unhatched insect egg. It floats through the air, sperm carried by two pale “balloons.” Such wind-borne pollen causes misery for allergy sufferers in much of the world, where it falls heavily, as it has for millions of years.

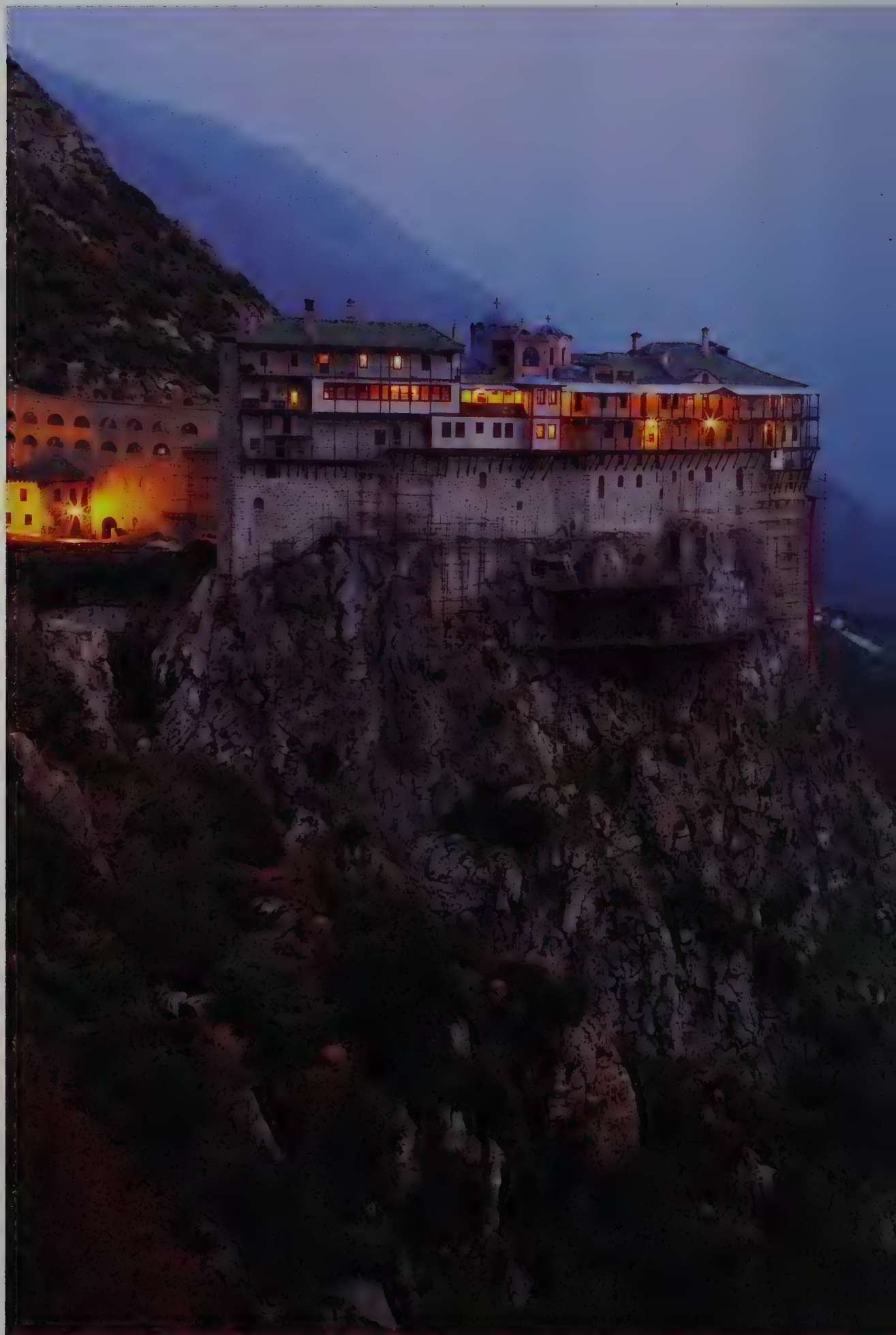


The ancient monastic community of Mount Athos in northern Greece still beckons men who seek to satisfy a spiritual hunger. Picking persimmons at dusk, an Eastern Orthodox Christian monk lives much as his brethren did a thousand years ago.

CALLED TO THE HOLY

A dark, moody photograph of a tree with bright red berries and a small white owl perched on a branch. The owl is positioned in the upper center, looking towards the left. The berries are clustered on the left side of the frame. The background is dark and textured, suggesting a forest or garden setting.

MOUNTAIN



Redoubt of the reclusive, Simonos Petras monastery was founded in 1257 more than 800 feet above the Aegean Sea. It is one of 20 monasteries on the steep-sloped peninsula, a popular pilgrimage site sometimes called the Christian Tibet.



BY ROBERT DRAPER

PHOTOGRAPHS BY TRAVIS DOVE

The holy peninsula of Mount Athos

reaches 31 miles out into the Aegean Sea like an appendage struggling to dislocate itself from the secular corpus of northeastern Greece. For the past thousand years or so, a community of Eastern Orthodox monks has dwelled here, purposefully removed from everything except God.

They live only to become one with Jesus Christ. Their enclave—crashing waves, dense chestnut forests, the specter of snowy-veined Mount Athos, 6,670 feet high—is the very essence of isolation.

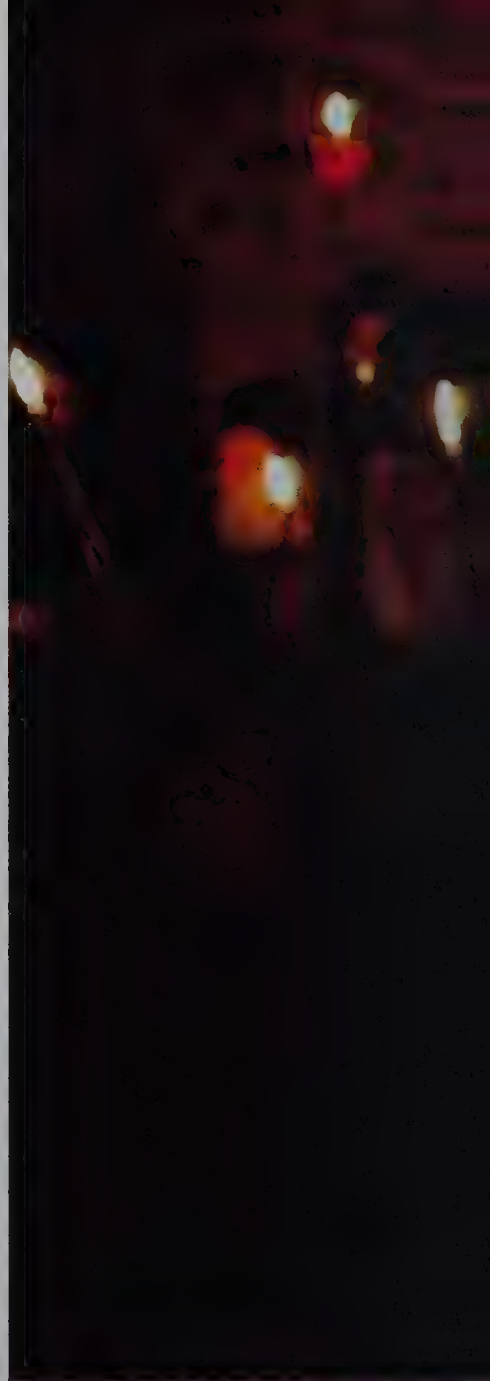
Living in one of the peninsula's 20 monasteries, dozen cloisters, or hundreds of cells, the monks are detached even from each other, reserving most of their time for prayer and solitude. In their heavy beards and black garb—worn to signify their death to the world—the monks seem to recede into a Byzantine fresco, an ageless brotherhood of ritual, acute simplicity, and constant worship, but also imperfection. There is an awareness, as one elder puts it, that “even on Mount Athos we are humans walking every day on the razor’s edge.”

They are men—exclusively. According to rigidly enforced custom, women have been forbidden to visit Mount Athos since its earliest days—a position born out of weakness rather than spite. As one monk says, “If women were to come here, two-thirds of us would go off with them and get married.”

A monk cuts his ties from his mother but gains another: the Holy Virgin Mary (who, legend has it, was blown off course while sailing to Cyprus, stepped foot on Mount Athos, and

blessed its pagan inhabitants, who then converted). He forms an intense bond with his monastery’s abbot or his cell’s elder, who becomes a spiritual father and, in the words of one monk, “helps me find my personal relationship with Christ.” The retirement or death of these eminences can be difficult for the younger monks. Conversely, a young man’s decision to return to the world may also be wrenching. “Last year one left,” recalls an elder. “He didn’t ask for my opinion,” he adds, his voice betraying a fatherly hurt, “so it’s just as well that he’s gone.”

Robert Draper is a National Geographic contributing writer. This is photographer Travis Dove's first assignment for the magazine.





Monks chant “Christos anesti—Christ is risen” during a midnight vigil. This Easter gathering ends seven weeks of solemn fasting. Monks rise to pray during the quietest hours of the night because that is when they believe the heart is most open.

Christian monks (derived from the Greek root *monos*, or “single”) first began forming collective refuges, or monasteries, in the Egyptian desert in the fourth century. The practice spread across the Middle East and into Europe, and by the ninth century hermits had arrived on Mount Athos. Since that time, as civilization has grown more complex, the reasons for distancing oneself from society and turning to monasticism have multiplied. Indeed, after two world wars and communism reduced the monastic population to 1,145 in 1971, the past decades have seen

a rebirth. A steady influx of young men—often with college degrees, a number from the former Soviet bloc—has dramatically increased Mount Athos’s ranks to nearly 2,000 monks and novices, while Greece’s entrance into the European Union in 1981 made the peninsula eligible for EU preservation funds.

“There are 2,000 stories here—everyone has their own spiritual walk,” says Father Maximos, whose own walk began in Long Island as a teenage devotee of edgy musical artists like Lou Reed and Leonard Cohen, and who later

became a theology professor at Harvard before resigning to “live my life closer to God.”

Many such journeys begin uneasily. An Athens boy sneaks away from his household, and when his brother comes to Mount Athos to fetch him, the boy warns, “I’ll just escape again.” A Pittsburgh grocer’s son stuns his parents with his decision—which, two years later, he acknowledges may be temporary, saying, “I mean, who knows what God has planned?” If the aspirants appear unready, their spiritual father will urge them to go back. Otherwise, the candidate will be tonsured under candlelight: The abbot cuts a tiny cross out of the hair on his scalp, bestows him with the name of a saint, and a monk is born.

Their stories hardly end when they enter Mount Athos. A wayward hippie from Australia named Peter is now Father Ierotheos, an accomplished baritone chanter at the Iviron monastery. Father Anastasios learned to paint here and now exhibits his work in places as far-flung as Helsinki and Granada, Spain. Father Epiphanius took it upon himself to restore the ancient vineyards of Mylopotamos, and today he exports excellent wine to four countries, in addition to publishing a cookbook of monks’ recipes in three languages.

For better or for worse, the monastic brotherhood consists of men who finally cannot help but be who they are, fleshed out beneath their robes. Some are independent by nature and opt to live on their own in countryside cells. Some are small-minded—and indeed, as one monk says, “monastery life can be absolutely consumed with pettiness.” However, the very best of them do not merely radiate goodwill but seek out where it’s most needed. Father Makarios of the Marouda cell near Karyes is such a man, freely bestowing on strangers his spare coat, his spare room, all of the money in his pocket. “With real faith,” the 58-year-old monk with animated green eyes says, “you have freedom. You have love.”

The monasteries are anything but monolithic. The seaside Vatopediou monastery is rich with

Byzantine treasures and ambition—among its monks is a full-time music director—while the decidedly agrarian Konstamonitou monastery embraces a rustic lifestyle free of electricity or donations from the European Union. (“You cannot be ascetic with all these easy things,” observes one of its elders.) The monks of Mount Athos did not leave behind their human audacity, attested to by the glorious positioning of Simonos Petras, a monastery suspended high over an infinite seascape as if clinging to heaven’s ladder. Some monks, however, commit to the hermitic barrenness of raggedy huts along the cliffs of Karoulia.

Still others opt for zealotry. Such is the case for the residents of Esfigmenou, a thousand-year-old monastery long tormented by pirates and fires and repressive Ottomans, but now a victim of its own radicalism. Having renounced the Ecumenical Patriarchs’ policy of dialogue with other Christian denominations and hung out a banner proclaiming “Orthodoxy or Death,” the Esfigmenou brotherhood has been cast out by Mount Athos’s ruling body, known as the Holy Community. It now subsists on outlaw defiance and donations from sympathetic corners of the outside world. “We’ll continue our struggle,” declares its renegade abbot. “We place our hope in Christ and the Holy Mother—and no one else.”

To leave Mount Athos for whatever reason is, in local parlance, to “go out into the world.” Of course, the peninsula remains affixed to Earth, and some 2,000 secular laborers share it with roughly the same number of monks. Mount Athos has been part of Greece since 1924. Its local governance resides in Karyes, the dusty capital and depot where shipments from the outside world and newly arrived Eastern Orthodox pilgrims are deposited. (Visitors must apply for a special permit; the Holy Community admits roughly a hundred males for up to four days at a time.)

As the junction between the fixed and the transient, Karyes teems with incongruities: a monk lumbering down the stone pavement with a gnarled cane in one hand and a Nike tote bag



in the other; shops selling candles, rosaries, and bottles of ouzo. The police force headquartered here handles the occasional public intoxication or shoplifting case. In addition, the Holy Community—the world’s longest continually functioning parliament—resides in Karyes. Its members pore over matters as large as relations with the EU and as small as who will rent a particular store. Every change on Mount Athos represents a risk that must be weighed.

Mount Athos has survived by bending where it must, though never without fretfulness. St. Athanasios, who founded the Megistis Lavras monastery in 963, infuriated the hermits by introducing audacious architecture into an otherwise rustic landscape. Roads and buses, then electricity, then cell phones have all been sources of angst. The latest encroachment is the Internet. A few monasteries have conducted ever so timid forays into cyberspace—ordering

spare parts, communicating with lawyers, obtaining scholarly research. “It’s a great danger to be connected to the outside world,” cautions one monk. “Most of the monks weren’t even informed about 9/11.”

The outside world creeps ever closer. Mount Athos’s newest monks have college educations, laptops, and little experience with raising chickens. Yesteryear’s mules have mostly been replaced by vans and Range Rovers. Worries persist that the European Union donations will continue only with strings attached—such as the insistence that women be permitted to visit the peninsula. In these ways Mount Athos cannot elude mortal preoccupations.

Yet the brotherhood proceeds as it always has: inchwise, turned ever inward, glorying in the unseen—“digesting death,” in the words of one of its preeminent scholars, Father Vasileios, “before it digests us.” □



PATH TO SANCTITY *Sounding a call to prayer with the rap of a mallet on a wooden board, a monk leads an Easter procession of fellow monks and lay visitors. Guarded by 6,670-foot-high Mount Athos (below, in background) and laced by rustic paths still traveled on foot and by mule (bottom left), the enclave's low-tech serenity attracts tens of thousands of pilgrims yearly—men only. Dedicated to the Virgin Mary, the peninsula is off-limits to all women and the temptations they might represent. Father Mardarios (top left), a former nightclub bouncer, applies his brawn to clearing ground for a garden. "Too many rocks," he grunts, "like my sins."*







These two monks have shared the same small cell for more than 50 years. Humor helps maintain harmony, as does respect for seniority. Father Nektarios (at left) says of Father Christoforos, "He's followed my will as the elder all these years."

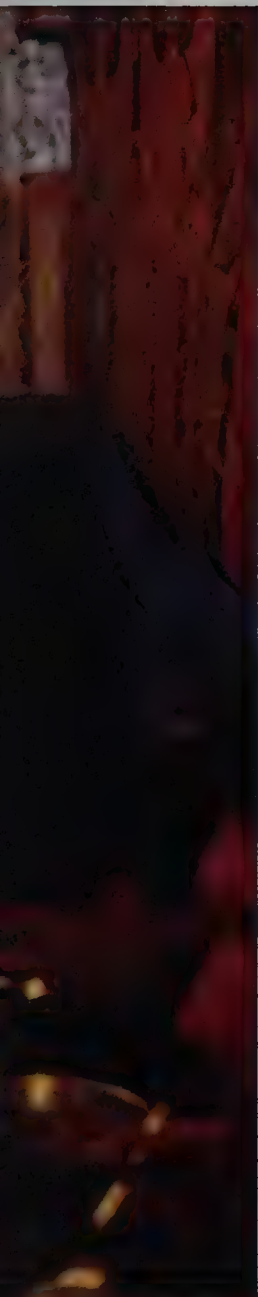




Monks of Esfigmenou monastery gather olives as they always have. But their vocal disdain of Orthodox patriarchs who have sought reconciliation with the Roman Catholic Church has led Mount Athos's ruling body to disown them.

ETERNAL BROTHERHOOD *A monk forsakes one family to join another. He communes with his brother monks at mealtimes—albeit silently, as in the ornate Byzantine refectory of the Xenofontos monastery (below). The monastery's abbot becomes his spiritual father, though all elders are approached with deference (bottom right). The monks remain united even in death: Their bones are washed in red wine—echoing an ancient Greek custom—and placed together in an ossuary (top right). Says Father Makarios of Simonos Petras, “For those who consider themselves already dead to the world and are living for God, leaving this world is easy.”*





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John and Shirley Spinelli included National Geographic in their estate plans.

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Society Updates



How does a contortionist bend her body in half (above) and not hurt herself? Scientists and doctors decode this and other confounding physical feats in *Humanly Impossible*. Two episodes air back-to-back on December 6 at 8 p.m.

ON ASSIGNMENT Not Quite Quitting Time

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To receive a payment from this Settlement, simply fill out a Claim Form and mail it no later than April 1, 2010. You will be required to provide one form of proof that you paid for Zetia® or Vytorin®. The amount you get depends on how much Zetia® or Vytorin® you paid for, and how many valid claims are filed.

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The Court will determine whether to approve the Settlement and attorneys' fees at a Fairness Hearing held on **February 8, 2010**.

The Court has appointed lawyers to represent you at no cost to you. You may choose to hire your own lawyer at your own expense.

For Information About the Proposed Settlement, Your Legal Rights and Filing a Claim:

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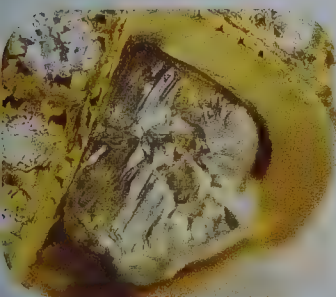
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Sometimes it's impossible to improve on perfection. When the world's most desired stone is pulled from the ground, why not just brush off the earth and leave it alone? White cut diamonds may be nice for a polite kiss on the cheek, but extra large uncut diamonds can really ignite some raw passion. And isn't that what a great piece of jewelry is all about? These few rare 2 carat plus natural stones will certainly turn up your thermostat.

A real diamond in the rough

For centuries, large raw diamonds were treasured without a hint of facet or polish. We believe the early artisans were on to something. After a search through countries on four continents, we have found a cache of rare, very large, 2 carat plus uncut diamonds at a



Similar rough diamonds sell elsewhere for thousands! Please compare the size and price of our raw diamond in the Stauer Raw Diamond Necklace with those at your local jewelry store.

spectacular price from our Belgium dealer. Major gemstone experts across the globe have commented that rough diamonds will be the fastest growing trend on "the red carpet" this year and our long love affair with flawless cut white gemstones may have some competition. All one has to do is flip through the world's most exclusive catalog to find that "rough is all the rage." Our luxury retail friends in Texas recently featured a raw solitaire for \$6,000, but they buy in such small quantities that they cannot compete with us on price. You see, Stauer is one of the largest gemstone buyers in the world and last year bought over 3 million carats of emeralds. No regular jewelry store can come anywhere close to that volume.

Equal parts "rough" and "refined"

Our **Raw Diamond Necklace** is a balanced blend of



geology and geometry. Each one-of-a-kind raw diamond is fitted by hand into its "cage," a crisscross embrace of gold vermeil over the finest .925 sterling silver, bead-set with 18 round diamonds. The caged diamond hangs from a triangular bail with an additional 8 diamonds (26 total). The pendant is suspended from an 18" gold vermeil rope chain with spring ring clasp. Each raw diamond is naturally unique. This is an extremely limited edition since it took us 3 years to find this small cache of stones.

Show off your Stauer **Raw Diamond Necklace** for 30 days. If you're not feeling the rush of raw, large diamonds, simply return it for a full refund of your purchase price. But if you feel like experiencing the unique perfection of natural uncut beauty, you have found the way.

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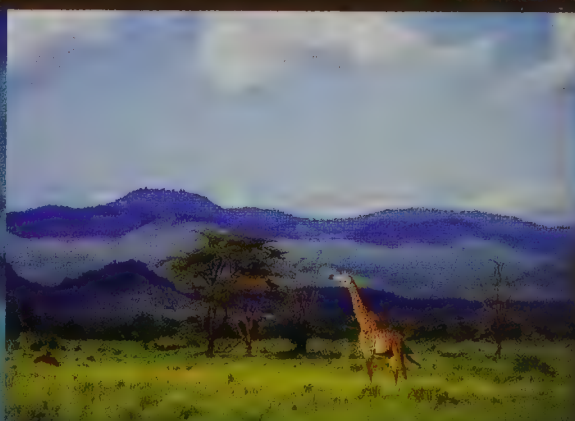
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THE MAASAI WILDERNESS CONSERVATION TRUST

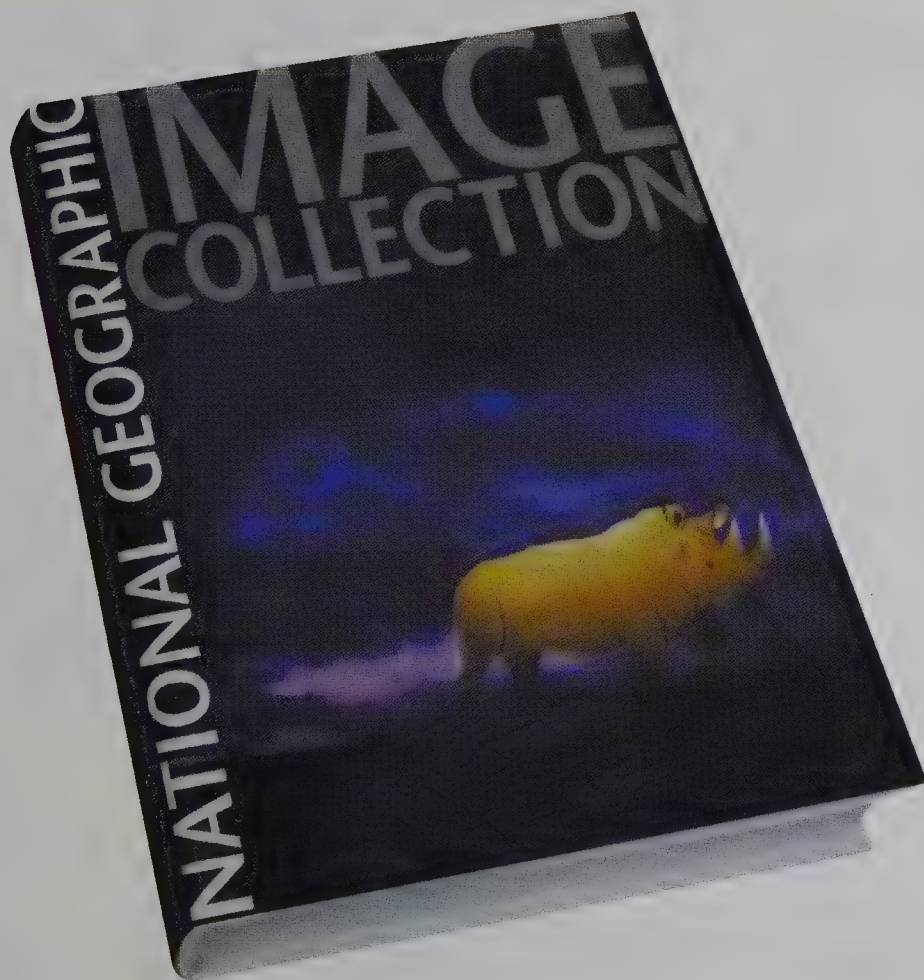


The mission of the Maasai Wilderness Conservation Trust is to preserve healthy ecosystems and biodiversity within the Maasai tribal lands of East Africa through conservation programs that create sustainable benefits for the Maasai people. The legendary wilderness of Africa's vast grassland ecosystems and the traditional culture of the Maasai people both face daunting challenges to survive and

co-exist in a sustainable manner. The fate of both rests in the Maasai's hands. Your donation will support MWCT's pioneering community partnership in establishing land conservancies, recovering lion populations, and improving education and health services through ecotourism revenues...a new model for preserving landscapes and wildlife by addressing the needs of people.

maasaiwilderness.org

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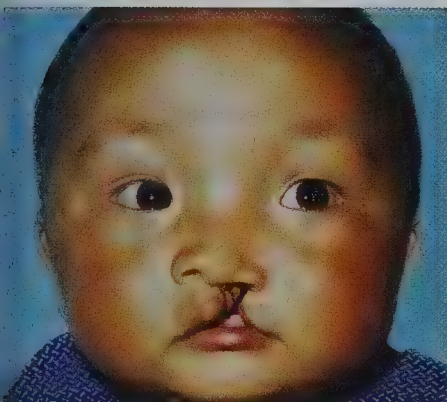
Big Bloom In the Indonesian wilds, the six-foot-plus flower of the *Amorphophallus titanum*, or krubi plant, emits an odor like rotting flesh to lure pollinating carrion beetles. At the New York Botanical Garden in 1937, it attracted crowds instead. Despite tender care and frequent repotting, this krubi had not flowered since the garden's acquisition of its 60-pound tuber in 1932. By 1937 the tuber had packed on another 53 pounds—and its blossoming proved a surprise. Though the garden's botanists coaxed a second krubi into flower in 1939, and several of the plants remain in its collection, no *A. titanum* has bloomed there since. —Margaret G. Zackowitz

Flashback Archive Find all the photos at ngm.com.

PHOTO: WIDE WORLD PHOTOS, INC., NATIONAL GEOGRAPHIC STOCK

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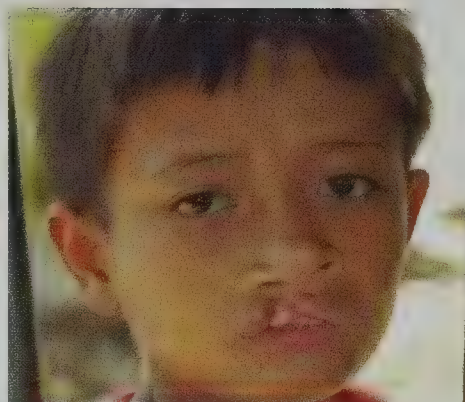
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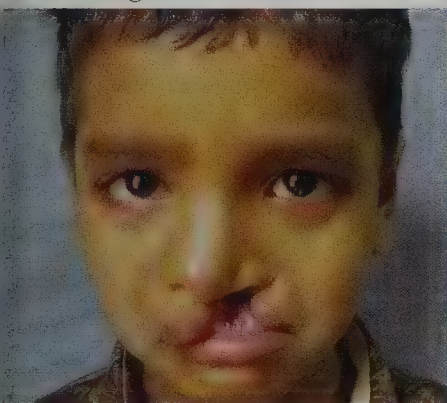
Ming, 6 months, China



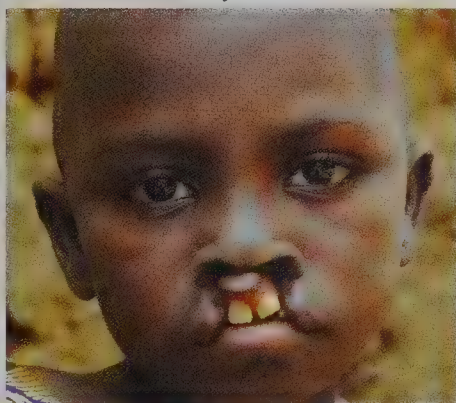
Shiva, 1 year, India



Mot, 13 years, Cambodia



Durgap, 5 years, India



Funmi, 8 years, Nigeria



Salazar, 5 years, Philippines

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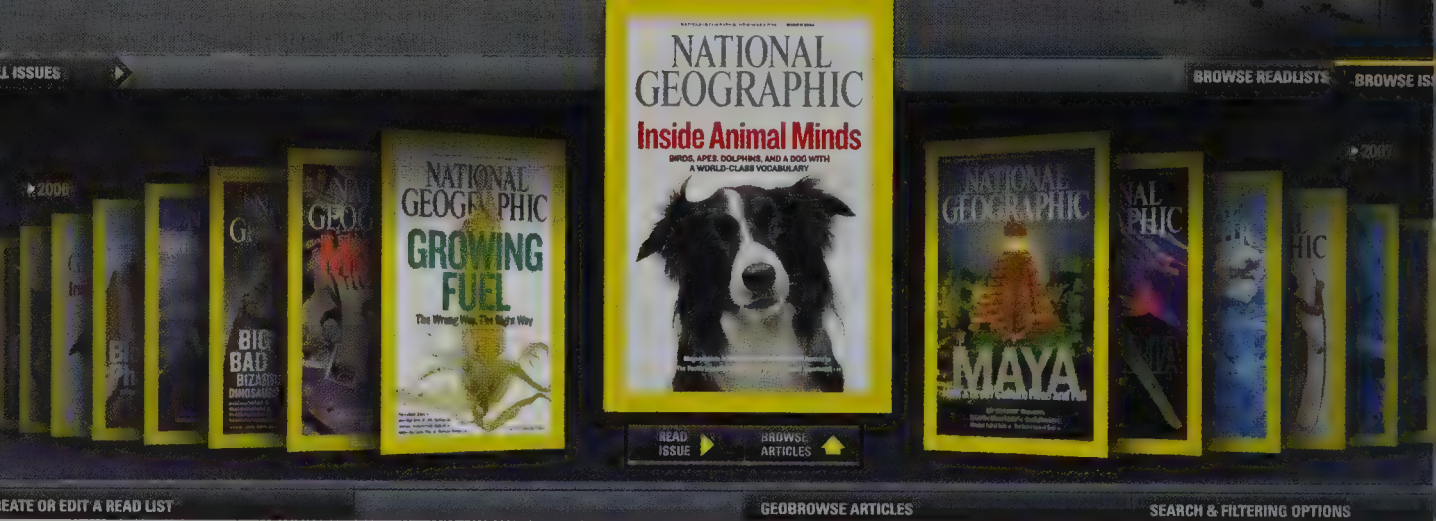
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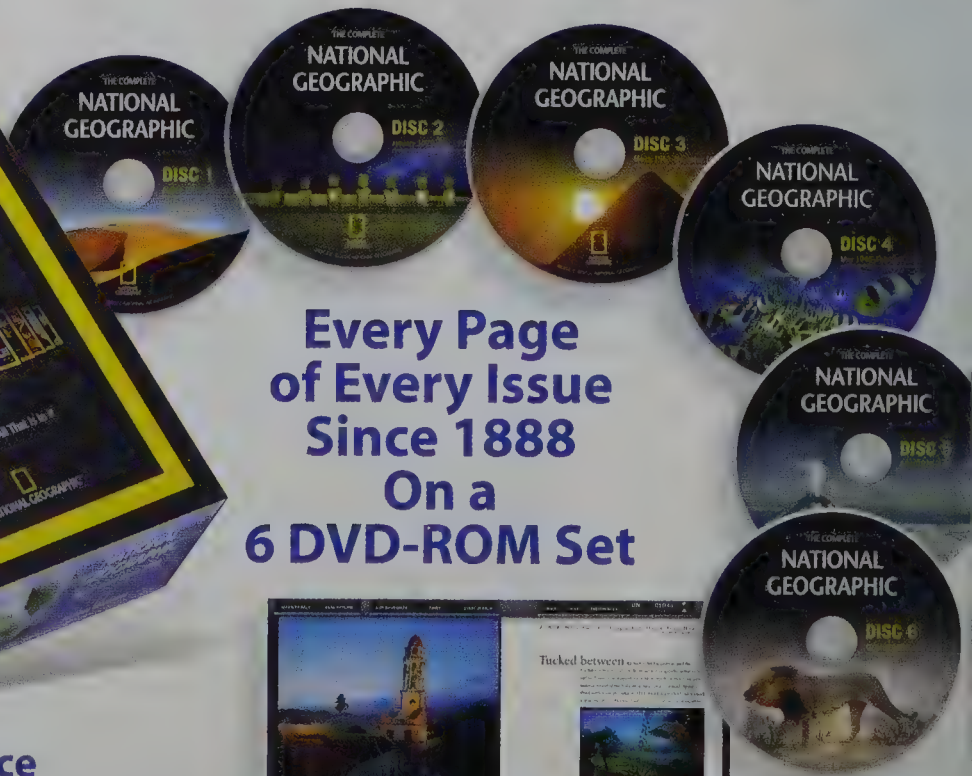
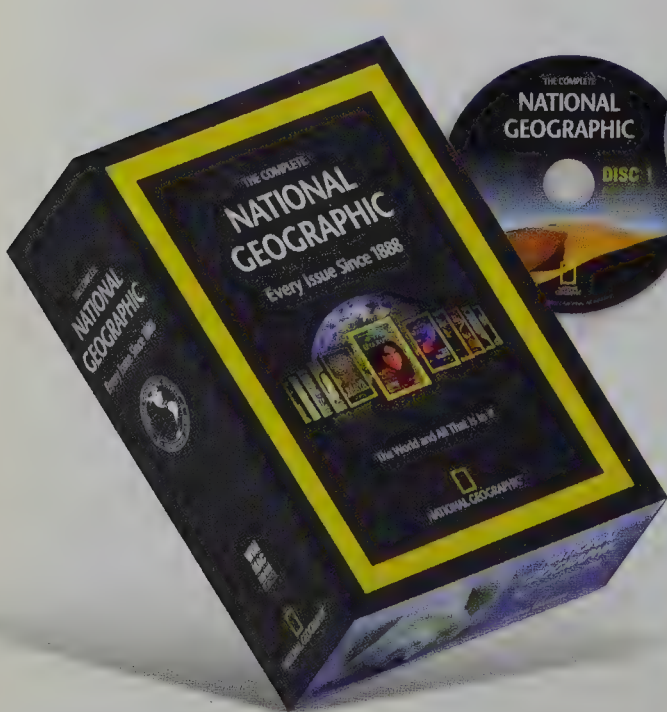
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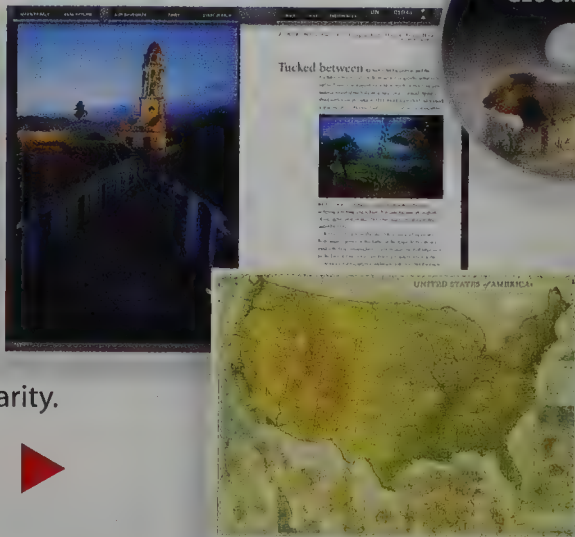
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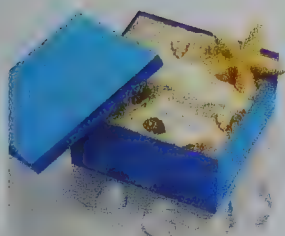
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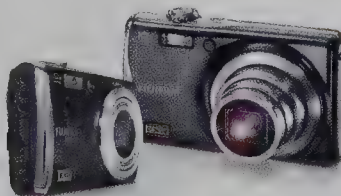
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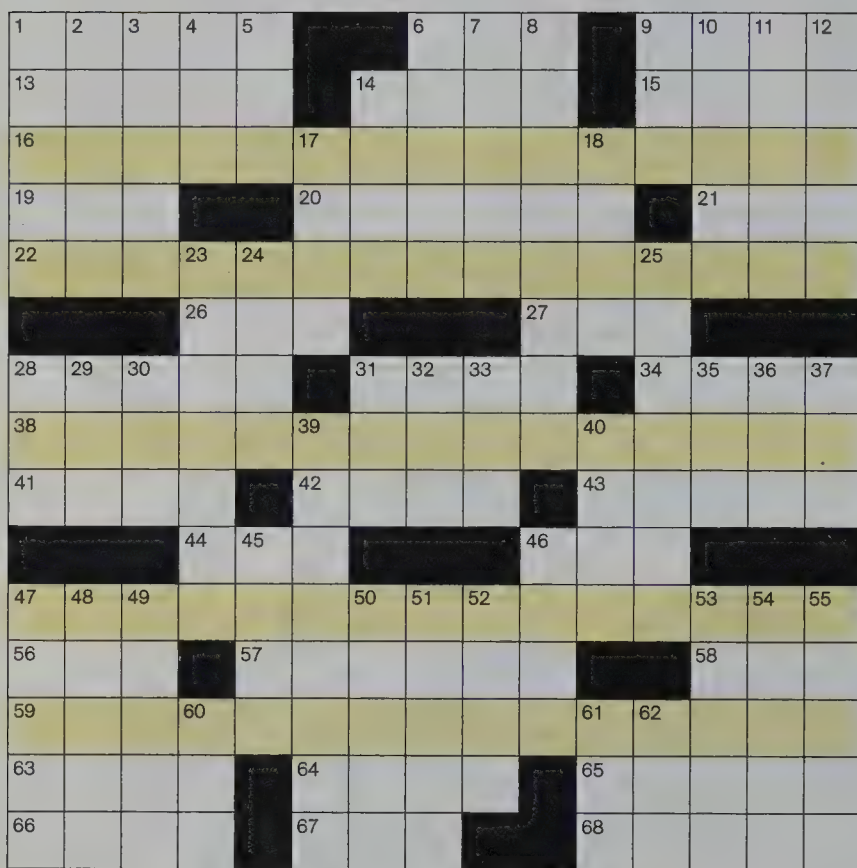


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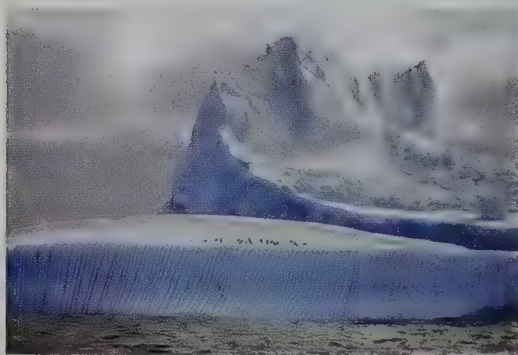
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GEOPUZZLE



DOWN

- 1 Espresso, e.g.
- 2 "It's ___!" (We're in business!)
- 3 NPR host Hansen
- 4 Lab's doc
- 5 Verb suffix of yore
- 6 Payment option
- 7 Cures, perhaps
- 8 Three-level ancient galleys
- 9 Big-screen Cleo, in 1963
- 10 Son almost slain by Abraham
- 11 One born on Labor Day, e.g.
- 12 Furnish with funding
- 14 Dietary fiber source
- 17 Online pub
- 18 Fervor
- 23 Big oaf
- 24 Frigate's frame
- 25 Facial-piercing adornment
- 28 ___ Dhabi, Persian Gulf capital
- 29 Hint that may be hot
- 30 Choose
- 31 B&O and others
- 32 Poetic tribute
- 33 Title for Caine or Connery
- 35 Contribute
- 36 Color of krill that feed South Georgia's wildlife
- 37 Sample
- 39 Robots
- 40 What a melting Pole or scarce krill year may be
- 45 Receding sea inside Asia
- 46 "Strike this," in proofing
- 47 A poem's has feet
- 48 Blow away
- 49 Hooded snake
- 50 Defense acronym
- 51 One of Chekhov's "Three Sisters"
- 52 Kind of ice that crushed Shackleton's ship
- 53 Strip of gear, as a ship
- 54 Bar of gold
- 55 Vespiaries and aeries
- 60 Bygone Egypt-Syr. alliance
- 61 Twice, musically
- 62 'Zine team



Paradox Island

Puzzle by Cathy Allis

It is icy yet improbably green in parts. Bright sun can swiftly turn to howling bluster. Its animals fell prey to hunters but have had a major revival. Tinted clues pay homage to mercurial South Georgia. For hints to the puzzle, read "Resurrection Island," page 56.

ACROSS

- 1 Produce offspring, à la glaciers, whales, and 22 Across
- 6 "Spring ahead" abbr.
- 9 Like some vaccines
- 13 One may go on it
- 14 Kodiak, for one
- 15 "The doctor ___"
- 16 Atmospheric condition, literally, in a South Georgia rookery
- 19 It may blow hot and cold
- 20 ___ d' (headwaiter)
- 21 Back in time
- 22 South Georgian female with a three-mammal name
- 26 Third qtr. mo.
- 27 Mid-11th-century yr.
- 28 Lagoon's surrounds
- 31 Its hips may be in tea
- 34 Hair line
- 38 South Georgia suffers from a meteorological version of this
- 41 Words with a point or par
- 42 Netizen, for instance
- 43 Sailor-collared blouse
- 44 "Krazy" comics character
- 46 Hibernation location
- 47 South Georgian bird with something special in its "cap"
- 56 Outgrowth of punk rock
- 57 Ethically indifferent
- 58 22.5 deg. compass point
- 59 "Icons of the great white continent" seen off South Georgia
- 63 University founder Cornell
- 64 "Oil ___ Blues" (theoretical song about whaling stations)
- 65 Dolt
- 66 Caboose
- 67 Nabokov novel
- 68 Certain NCOs

Answers in
Inside Geographic

TODAY
Thinking green

TOMORROW
Planning for blue



TOYOTA

toyota.com/future

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